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TREASURY DEPARTMENT.

Public Health and Marine-Hospital Service of the United States.

WALTER WYMAN, Surgeon-General.

HYGIENIC LABORATORY.—BULLETIN No. 34.

M. J. ROSENAU, Director.

MAY, 1907.



1. *Agamofilaria georgiana* n. sp., an Apparently New Roundworm Parasite from the Ankle of a Negress.
2. The Zoological Characters of the Roundworm Genus *Filaria* Mueller, 1787.
3. Three New American Cases of Infection of Man with Horse-hair Worms (species *Paragordius varius*), with Summary of all Cases reported to date.

BY

CH. WARDELL STILES.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

NOTICE TO LIBRARIANS AND BIBLIOGRAPHERS CONCERNING THE SERIAL PUBLICATIONS OF THIS LABORATORY.

The Hygienic Laboratory was established in New York, at the Marine Hospital Staten Island, August, 1887. It was transferred to Washington, with quarters in the Butler Building, June 11, 1891, and a new laboratory building, located in Washington, was authorized by act of Congress March 3, 1901.

The following *bulletins* [Bulls. Nos. 1-7, 1900 to 1902, Hyg. Lab., U. S. Mar.-Hos. Serv., Wash.] have been issued:

- No. 1.—Preliminary note on the viability of the *Bacillus pestis*. By M. J. Rosenau.
- No. 2.—Formalin disinfection of baggage without apparatus. By M. J. Rosenau.
- No. 3.—Sulphur dioxide as a germicidal agent. By H. D. Geddings.
- No. 4.—Viability of the *Bacillus pestis*. By M. J. Rosenau.
- No. 5.—An investigation of a pathogenic microbe (*B. typhi murium* Danyz) applied to the destruction of rats. By M. J. Rosenau.
- No. 6.—Disinfection against mosquitoes with formaldehyde and sulphur dioxide. By M. J. Rosenau.

No. 7.—Laboratory technique: Ring test for indol, by S. B. Grubbs and Edward Francis; Collodium sacs, by S. B. Grubbs and Edward Francis; Microphotography with simple apparatus, by H. B. Parker.

By act of Congress approved July 1, 1902, the name of the "United States Marine Hospital Service" was changed to the "Public Health and Marine-Hospital Service of the United States," and three new divisions were added to the Hygienic Laboratory.

Since the change of name of the Service the bulletins of the Hygienic Laboratory have been continued in the same numerical order, as follows:

No. 8.—Laboratory course in pathology and bacteriology. By M. J. Rosenau. (Revised edition March, 1904.)

No. 9.—Presence of tetanus in commercial gelatin. By John F. Anderson.

No. 10.—Report upon the prevalence and geographic distribution of hookworm disease (uncinariasis or anchylostomiasis) in the United States. By Ch. Wardell Stiles. (Second edition 1903.)

No. 11.—An experimental investigation of *Trypanosoma lewisi*. By Edward Francis.

No. 12.—The bacteriological impurities of vaccine virus; an experimental study. By M. J. Rosenau.

No. 13.—A statistical study of the intestinal parasites of 500 white male patients at the United States Government Hospital for the Insane; by Philip E. Garrison, Brayton H. Ransom, and Earle C. Stevenson. A parasitic roundworm (*Agamomermis culicis* n. g., n. sp.) in American mosquitoes (*Culex sollicitans*); by Ch. Wardell Stiles. The type species of the cestode genus *Hymenolepis*; by Ch. Wardell Stiles.

No. 14.—Spotted fever (tick fever) of the Rocky Mountains; a new disease. By John F. Anderson.

No. 15.—Inefficiency of ferrous sulphate as an antiseptic and germicide. By Allan J. McLaughlin.

No. 16.—The antiseptic and germicidal properties of glycerin. By M. J. Rosenau.

No. 17.—Illustrated key to the trematode parasites of man. By Ch. Wardell Stiles.

No. 18.—An account of the tapeworms of the genus *Hymenolepis* parasitic in man, including reports of several new cases of the dwarf tapeworm (*H. nana*) in the United States. By Brayton H. Ransom.

[Continued on third page of cover.]

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United States Public Health and Marine-Hospital Service.

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SUMMARY.

This bulletin contains three articles on parasitic worms found in man.

In the first article a new species (*Agamofilaria georgiana*) of roundworm, apparently belonging to the family *Filariidæ*, is described. This very interesting, immature parasite, measuring 32 to 53 mm. in length, was taken from the ankle of a negress at Darien, Ga. Its mouth is surrounded by two small lateral papillæ and four submedian lip-like papillæ. The anatomy is described so far as the material permitted. Nothing is known of its life history.

The second paper contains a summary of the zoological characters of the genus *Filaria*, so far as known, and a list (with synonymy) of the roundworms of the family *Filariidæ* which have been reported for man. It is shown that zoologically this group is in a very unsatisfactory condition systematically.

In the third paper all of the cases of infection of man by horsehair worms (*Gordiidæ*) are brought together and three unpublished cases are reported. The conclusion is drawn that the popular dread of these worms is not well founded, for they are rare, accidental, and as a rule, at least, not dangerous parasites in man. The common species in this country is *Paragordius varius*.

The illustrations for these three papers have been prepared by Mr. Leonard Wilder.

All bibliographic references are taken from Stiles & Hassall, Index-Catalogue of Medical and Veterinary Zoology.

AGAMOFILARIA GEORGIANA N. SP., AN APPARENTLY NEW ROUNDWORM PARASITE, FROM THE ANKLE OF A NEGRESS.^a

By CH. WARDELL STILES, PH. D.,

Chief of Division of Zoology, Hygienic Laboratory, U. S. Public-Health and Marine-Hospital Service.

(Figs. 1-25.)

Eighteen specimens of a nematode worm (figs. 1-2) have been forwarded to this laboratory by Dr. St. Joseph B. Graham, of Savannah, Ga., with the history that they had been taken from a sore on the leg of a negress at Darien, Ga. All of the specimens are immature; they are not especially well preserved, and on this account they have presented considerable difficulty in technique and interpretation. Accordingly, it has been impossible to give a complete description of the species. But as the worm seems to be a new parasite for man, and as certain points in the anatomy could be recognized, it seems advisable to place the parasite on record, notwithstanding the fact that several important points are open to different interpretations and that the description is therefore necessarily incomplete.

MEDICAL HISTORY OF THE CASE. For the following medical history of the case I am indebted to Dr. P. S. Clark:

In August, 1896, I was called to see a negress; age, 57; occupation, washerwoman. I found her suffering with pain and swelling in and around her left ankle and instep. She said she could feel something moving in the swollen places, but there was no abrasion on the skin. I gave her a liniment with which to rub the affected parts. This did not seem to be of much benefit. She continued to suffer for twelve or eighteen months, when suddenly she discovered a worm coming out of the most swollen place; and worms continued to appear singly at intervals for a month, when the opening healed and the pain and swelling subsided, her foot became entirely well, and gave no further trouble. She died in 1903 of tuberculosis of the lung. I think there were as many as two or three dozen of these worms extruded from this opening during the above-mentioned period.

^aBy permission of the Surgeon-General, and in response to an invitation, this paper was presented at the annual meeting of the American Society of Tropical Medicine, at Philadelphia, Pa., March 27, 1906.

Patient was never confined to bed as the result of the above condition. I preserved some of the worms in alcohol and gave them to my friend, Dr. Ralston Lattimore, of Savannah, Ga., as a zoological curiosity, who in turn handed them to Dr. St. Joseph B. Graham, of Savannah, who was kind enough to send some specimens to you for study and identification.

SYSTEMATIC POSITION. The worms in question would probably be classified by many authors as a *Filaria*. Such classification is, however, not satisfactory, for in the absence of the adult stage it is difficult to determine to what group of the *Filariidae* the parasites may belong. To place the species in *Filaria* would be adding confusion to an already very confused genus. Possibly these worms belong in *Tetracheilonema*, but too little is known about the type species of this genus to justify a definite opinion.

As the most satisfactory solution of the systematic dilemma which presents itself, I propose to classify these parasites under the collective term—

AGAMOFILARIA new name.

DIAGNOSIS.—*Filariidae*: A purely collective group, to contain agamic forms of *Filariidae*, which have not yet reached a stage in their development permitting of their being determined generically. Such a group has no type-species. Compare *Agamodistomum*, *Amphistomulum*, *Agamomermis*, *Merminthoidum*, *Agamonematodum*, etc.

As the species under consideration does not seem to be identical with any form described for man, and as it is not apparent at present that it is identical with any species described for other hosts, I propose to recognize it as a new species under the name *Agamofilaria georgiana*, with the following characters:

a *Tetracheilonema* Diesing, 1861a, 621, 711 (Dec. 6, 1860) (m. *quadrilabiatum*).

GENERIC DIAGNOSIS.—*Filariidae*: "Corpus longissimum, filiforme. Caput quadrilabiatum, labiis in quadrangulum dispositis. Os ad basin labiorum. Extremitas caudalis spiraliter torta. Penis vagina tubulosa. Apertura genitalis in anteriore corporis parte; uterus ——— Vivipara.—Ayium brasiliensium in cavo abdominis et sub cute colli endoparasita."—Diesing, 1861a, 711.

The type species presents the following synonymy and diagnosis:

Tetracheilonema quadrilabiata (Molin, 1858) Diesing, 1861:

1858: *Filaria quadrilabiata* Molin, 1858, 417 (in *Tinamus rufescens*, at Caicara; and *T. maculosus*, in Brazil).—Diesing, 1861a, 711.—Stossich, 1897, 77.

1858: *F. tinami* M. C. V., MS., in Molin, 1858, 417.

1861: *Tetracheilonema quadrilabiatum* (Molin, 1858) Diesing, 1861a, 711.—Stossich, 1897, 77.

SPECIFIC DIAGNOSIS.—*Tetracheilonema*: "Os quadrilabiatum, labiis conicis, magnis; corpus inflexum; extremitas anterior sensim attenuata; posterior spiraliter torta; extremitas caudalis maris attenuata, obtusa; vagina penis tubulosa, extremitate libera incrassata; penis ———; extremitas caudalis feminae attenuata, obtusa. (Vivipara.) Longit. mar $1\frac{1}{4}$ – $1\frac{1}{2}$ " [30 to 33 mm.]; crassit, $\frac{1}{3}$ ". Longit. fem., $1\frac{1}{2}$ –2" [36 to 50 mm.]; crassit, $\frac{1}{2}$ ".

"HABITACULUM.—*Tinamus rufescens*, Novembri, Caicara: in cavo abdom.—*T. maculosus*, in Brasilia: sub cute colli (Natterer). M. C. V."—Molin, 1858, 417.

AGAMOFILARIA GEORGIANA, new species.

(Figs. 1 to 25.)

1906: A new species of parasite in man, Stiles, 1906, Apr. 21, 839-840, N. York M. J. (1429), v. 88 (16); 1906, Apr. 21, 1232, J. Am. M. Ass., Chicago, v. 46 (16).

SPECIFIC DIAGNOSIS.—*Agamofilaria*: Adults unknown.

Agamic form: Length 32 to 53 mm. Body cylindrical, of more or less uniform diameter the greater part of the length, with a maximum diameter of about 560 to 640 μ ; gradually attenuated toward both extremities, slightly more gradually cephalad than caudad. Mouth terminal, central, circular, small, unarmed, but surrounded by six papillae. Four of these are prominent, submedian, 23 μ elevations, having in some cases almost the appearance of lips; two smaller papillae are latero-median. Anus a transverse slit, about 44 to 56 μ in transverse diameter, situated ventrally, 64 to 128 μ from end of tail. Tip of tail provided with a small conical projection 8 to 13 μ long by 4 μ in diameter. Excretory pore 0.432 to 0.520 mm. from anterior end. Cuticle in general without transverse striation, except for a fine transverse striation in the anal region, especially postanal, and a (probably pseudo-) striation in the esophageal region. Median lines visible externally in glycerine specimens merely as lines of demarcation between the muscular fields; on section, median bands are very slender, but are visible, and extend centripetally below the muscles, widening in breadth. Lateral bands rather prominent, and may be traced practically the entire length of the worm; they may attain a breadth of 96 μ , but they decrease in breadth cephalad (to about 15 μ) and caudad; they are divided into a dorsal and a ventral portion, which are not necessarily symmetrical and which are separated by a distinct line of single, subcuticular cells; the cells of the lateral bands are chiefly subcuticular, but near the head they extend centripetally in a single row in each half. Attached to the lateral bands, and hanging into the body cavity each side is a sinuous, longitudinal ridge, resembling the head-glands of strongyles, and provided with a central longitudinal canal which empties at the excretory pore; in the bridge of the esophageal region this glandular structure possesses a large apparently unilateral nucleus (296 to 316 μ by 90 to 132 μ), situated latero-ventrally. Esophagus simple, 2.5 to 2.9 mm. long, 88 to 114 μ in diameter (anteriorly) to 334 μ in diameter (posteriorly); its lumen is triradiate, each ray measuring about 10 μ . Chyle intestine straight, or very nearly so, rather large, at first compressed laterally, then rather quadrangular, with fibers running from the submedian lines toward the body wall; farther caudad it becomes flattened dorso-ventrally, measuring about 300 μ transversely by about 200 μ dorso-ventrally; its cells are columnar, about 9 μ in diameter by 30 to 90 μ high; the cuticle of the lumen is about 6.6 to 8.8 μ thick. Rectum about 200 μ long. Body cavity almost completely occupied by the intestine, lateral, longitudinal glands, and a reticular structure extending centripetally from the muscles toward the intestine; a considerable amount of granular material also present (? some of this possibly representing the primordium of the genital glands).

HABITAT.—Agamic form taken from superficial sores on the ankle of a negress (*Homio sapiens africanus*), at Darien, Georgia, U. S. A. Life history and source of infection known.

TYPE MATERIAL.—U. S. P. H. & M. H. S., No. 9726.

The following details were observed:

GENERAL EXTERNAL CHARACTERS.

SIZE.—The worms (figs. 1-2) vary in length from 32 to 53 mm., the eighteen specimens giving the following measurements: 32 mm., 34 mm., 36 mm., 37 mm., 38 mm., 40 mm., 42 mm., 45 mm., 47 mm., 49 mm., 50 mm., 52 mm., and 53 mm.

In the longest specimen (53 mm.) the cephalic extremity is bluntly rounded; 80 μ caudad of the mouth it is 128 μ in diameter; it swells gradually to 368 μ in diameter a short distance caudad of the posterior end of the esophagus.

In the specimen 44 mm. long, the diameter is 160 μ at a point 80 μ back of the mouth; the maximum diameter is 560 μ .

In the specimen 37 mm. long, the diameter 80 μ back of the mouth is 136 μ ; at 800 μ back of the mouth the diameter is 272 μ ; 1.6 mm. back of the mouth the diameter is 368 μ ; the increase is then rather gradual, and at the end of about the first third of the specimen the diameter attains 560 μ ; then a diameter of 576 μ is retained more or less uniformly, but with a slight variation, at some points reaching 624 μ ; toward the tail, the diameter begins to decrease, at first slowly, then more rapidly; at 1.6 mm. from the tip, it is 400 μ ; at 800 μ it is 272 μ (dorso-ventral diameter); at the anus the dorso-ventral diameter is 120 μ ; the tail then ends rather bluntly.

In a mounted specimen 32 mm. long, the diameter 80 μ back of the mouth is 128 μ ; at 800 μ it is 240 μ ; just before the end of the esophagus it is 432 μ ; just back of the esophagus there is a slight constriction, to 400 μ ; it then varies between 560 and 640 μ for the greater part of the length; near the tail it begins to decrease, reaching 432 μ at a point 1.6 mm. from the tip; it now decreases more rapidly, reaching 240 μ at a point 800 μ from the tip; at the anus, the dorso-ventral diameter is 80 μ .

In general, the body may attain a maximum diameter of about 560

to 640 μ and is more or less uniform for a considerable part of its

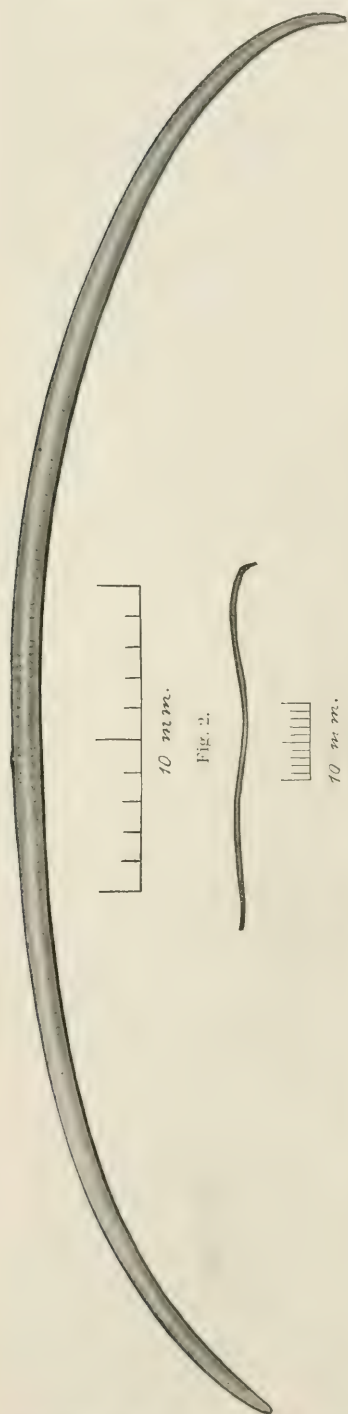


FIG. 1.—*Agamostlaria georgiana* from ankle of a negress at Darien, Georgia. Natural size.

FIG. 2.—Specimen of same, enlarged 4 times.

length; it tapers gradually toward both extremities, the attenuation toward the head being slightly more gradual than that toward the tail.

TORSION OF THE BODY.—These specimens present a torsion around the longitudinal axis, so that when the head is viewed dorsally, the anus of the specimen is shown in profile; when the specimen is so placed on a slide as to give a ventral view of the anus, the head is seen in profile.

HEAD. The head (figs. 3-5) is rather bluntly rounded, without any indication of a cephalic cone. The small terminal, central, circular mouth is surrounded by six papillae, which are directed forward.

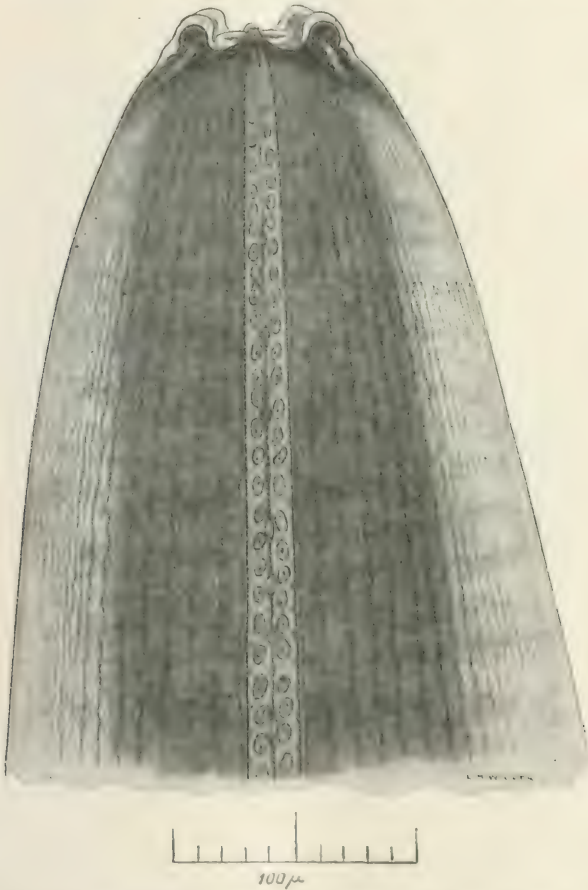


FIG. 3.—Head of same; greatly enlarged lateral view, showing the mouth surrounded by two small lateral papillae and four larger submedian lip-like papillae; note the lateral line with its two distinct rows of nuclei (one dorsal and one ventral), and a third, middle row of less distinct nuclei separating the others; note also the longitudinal striation due to the somatic muscles; the darker field is caused by the underlying esophagus.

Two of these papillae are small and latero-median. Four of the papillae are submedian and are much larger than the latero-median papillae; they bear some resemblance to lips, and frequently show a larger,

clearer portion, situated closer to the mouth, and of more lip-like appearance (fig. 4), and a smaller, darker, external ridge, which appears of more distinctly papillary nature; from base to tip these larger lip-like papillae measure about $23\ \mu$. There is some variation in the specimens, due possibly to their condition, which makes it difficult to infer just how these papillae would appear in perfectly fresh or in well-preserved material. Extending caudad from the more strictly papillary portion (the external ridge), in several cases structures were seen which were strongly indicative of nerves.

Cervical papillae have not been observed.

The *excretory pore* is small, medio-ventral, not prominent, 0.432 to 0.52 mm. from the anterior end.

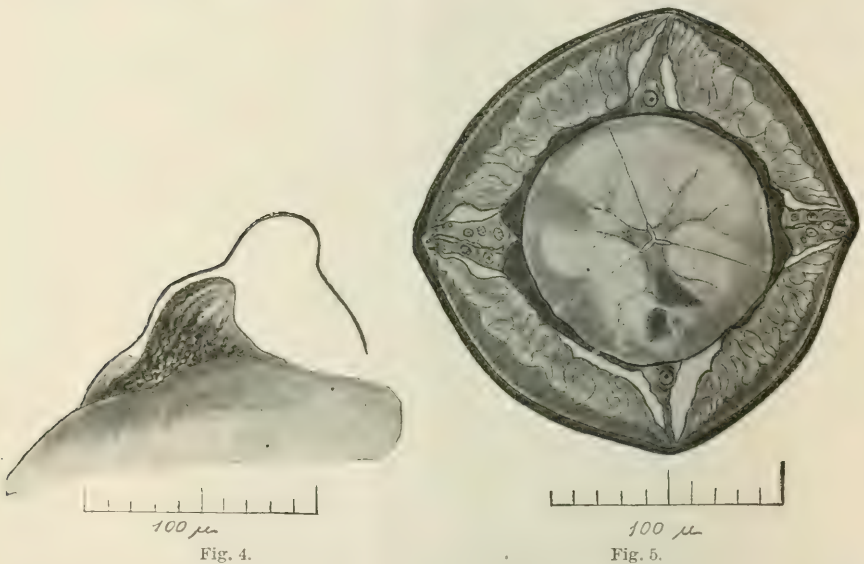


FIG. 4.—Greatly enlarged profile view of one of the submedian lip-like papillae, showing the lip-like projection near the mouth and the external papillary portion.

FIG. 5.—Enlarged transverse section of head, close to the mouth. Note the following points: The cuticle seems to present two layers; it shows thickenings near the lateral lines; immediately under the cuticle, the thin subcuticula is visible as a light line extending around the body; at the four longitudinal lines (dorsal, ventral, and two laterals) the longitudinal bands are seen, extending toward the esophagus, and connected by a circular bridge which surrounds the esophagus; the lateral bands are thicker than the median bands, and present a dorsal and a ventral half; each half shows a row of nuclei; besides these a single middle nucleus is seen; the muscles are divided into four quadrants by the longitudinal bands; centripetally of the more darkly colored contractile muscular layer the protoplasmic processes extend toward the esophagus, forming a mesh work; the esophagus is central and shows a triradiate lumen and radial symmetry.

TAIL.—The profile of the tail (figs. 7-9) is not uniform, but it bends slightly ventrad. In one mounted tail the transverse diameter at the anus is $128\ \mu$; in one mounted tail the dorso-ventral diameter at the anus is $80\ \mu$; and in one unmounted specimen, the dorso-ventral diameter at the anus is $120\ \mu$. In these three specimens, the anus is 96, 64,

and 80μ , respectively, from the tip of the tail; in two other specimens it is 104μ and 128μ , respectively, from the tip. The anus is a transverse slit about 44 to 56μ in transverse diameter.

At the apex of the tail, there is a small conical projection, 8 to 13.4μ long, 4.4μ in diameter; this may be curved slightly dorsad and is not equally prominent in all specimens.

CUTICLE. The cuticle at the anterior portion of the body is not so thick (about 3μ) as that (about 4 to 6μ) over the greater part of the worm (measurements taken from sections and also from worms). In general it shows no transverse striation; at the tail, however, quite a distinct but fine striation is visible in the postanal portion and in one



FIG. 6.—Enlarged transverse section of body through midgut region. Note the following details: The cuticle appears in two layers and presents four distinct thickenings, two near each lateral line; the subcuticula is visible between the cuticle and the muscles; the narrow dorsal and ventral median bands extend into the body cavity beyond the muscle layer and then increase in breadth; the division of the lateral bands into a dorsal and a ventral half is very distinct; near the cuticle, in the space between them, is seen a nucleus; nuclei are also visible in each half near the cuticle; the four muscular fields and the centripetal reticulum are very evident; the intestine is compressed dorsoventrally, and presents a high columnar epithelium with centrifugal nuclei and centripetal cuticular lining; between the lateral bands and the intestine is seen, each side, a section of the excretory gland, with its central canal.

specimen these striae may be followed cephalad to the plane of juncture of the rectum with the chyle intestine; some of the specimens also show a transverse striation in the esophageal region, but this is probably a pseudostriation, as it is not constant and as it is most prominent on one specimen in which the head is rather strongly curved.

A distinct longitudinal striation is visible upon microscopic examination; this is due, not to any striation in the cuticle but to the longitudinal somatic muscles.

LONGITUDINAL LINES.—The lateral bands are prominent, but externally the dorso- and ventro- median bands are barely recognizable; the position of the latter may, however, be distinguished externally, midway between the lateral bands, as longitudinal lines, at which the somatic muscles are thinner than usual, and in fact at which the respective muscle cells are slightly interrupted; the median lines may, however, be described as practically invisible externally; on section they are seen to be very narrow centrifugally, but slightly broader centripetally.

Lateral bands.—The lateral bands may be traced the entire length of the worm, from a point immediately back of the latero-median papillae

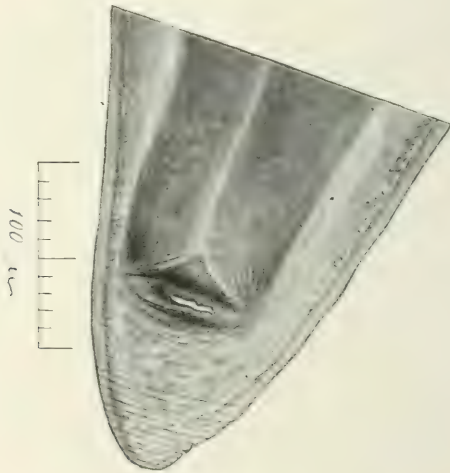


Fig. 7.

FIGS. 7-9.—Enlarged ventral (7) and lateral (8 to 9) views of the tail. Note the transverse striation in the post-anal portion; the broad transverse anal slit; the midgut is large, but the rectum is compressed dorsoventrally; the lateral band, with numerous nuclei, is prominent; various cells, nuclei, and muscles are seen.

at the anterior end to the end of the tail; in the esophageal region they are somewhat less distinct than in the midgut region. Very close to the mouth, in one specimen, the lateral band measures 15μ broad and shows two distinct and one rather indistinct row of nuclei directly under the cuticle; sections, however, show other nuclei farther away from the cuticle; in one section very near the mouth, the band measured 13.2μ dorso-ventrally; the band increases gradually in breadth; at the posterior end of the esophagus in one worm it measures 45μ ; in one specimen, it is 56μ and in another specimen 88μ at this point; at the equator of the worm it measures 90μ ; it retains this breadth more

or less uniformly to within a short distance from the anus, when it gradually decreases in actual breadth, although it may increase in relative breadth, owing to the decrease of the dorso-ventral diameter of the worm. The greatest breadth of the lateral band noticed in any specimen was 96μ . In one specimen it measured 30.8 at the anal plane.

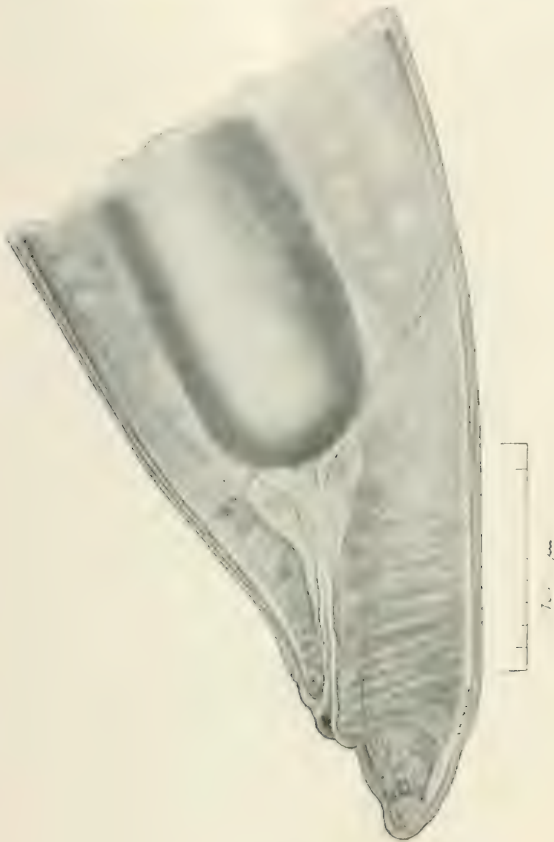


Fig. 8.

INTERNAL STRUCTURE.

Not an inconsiderable amount of the anatomy can be seen in specimens cleared in glycerine, but for an interpretation of some of the structures sections are necessary.

DIGESTIVE SYSTEM.—The intestinal canal consists of three distinct portions: a long undivided esophagus; a long chyle intestine (midgut), and a distinct rectum.

Esophagus.—The esophagus (figs. 5, 10, 11, 15) is 2.5 to 2.9 mm. long; anteriorly it is 88 to 114μ in diameter; caudad it increases in diameter, at first slowly, then more rapidly, attaining its maximum

(about 334μ) slightly in front of its caudal end. The measurements of the esophagus vary in different specimens. No differentiation into the dispharagus type was observed. A torsion of the esophagus is present. In its caudal half and at some other points the esophagus lies more or less exactly in the middle axis of the body, but portions of its anterior half may be decidedly excentric, nearing the dorsal surface of the worm. On section the outline is circular, but the lumen is seen to be triradiate, each leg of the 3-rayed star measuring about 10μ . The body of the

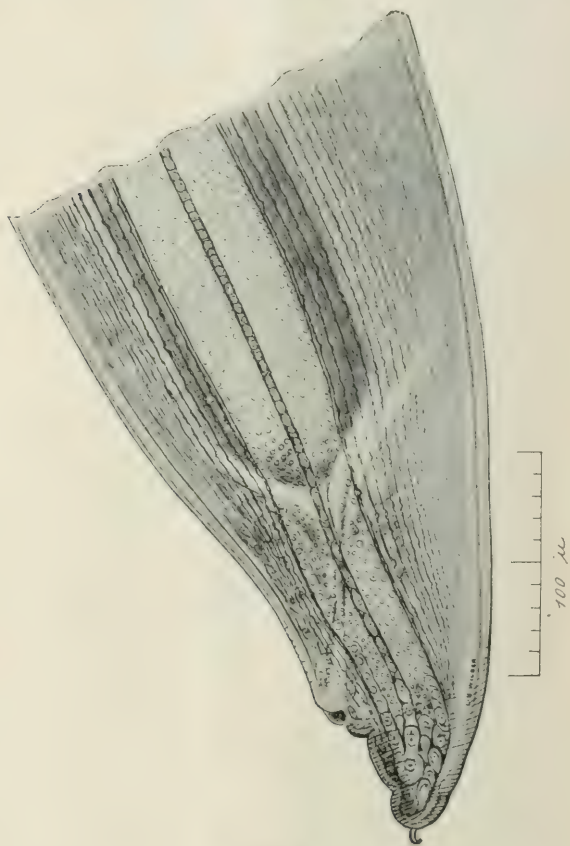


Fig. 9.

esophagus (figs. 5, 11) presents an exceedingly interesting arrangement of its component parts, but because of the poor condition of the material it is perhaps better not to attempt a definite interpretation at this time. It may, however, be stated that nuclei are visible at some points and that at other points there are structures which are indicative of nerves and of glands; further, that the component parts of the esophageal wall present an almost mathematically exact radial symmetry, the three chief fields of the symmetry being determined of course by the three legs of the triradiate lumen; finally, the component parts

of each of these three fields present a more or less exact symmetry. The esophagus is more or less surrounded by certain structures, which will be described farther on.

Chyle-intestine.—The chyle-intestine or midgut (fig. 13) is of nearly uniform diameter and runs straight from the posterior end of the esophagus to the anterior end of the rectum. Focusing upon the chyle-intestine through the body wall, one distinctly sees the bases of the intestinal cells; they are about 9μ in diameter and arranged much like the cells of a honey-comb.

Viewed in transverse section the chyle-intestine is seen to be at first somewhat compressed laterally, then it becomes rather quadrangular,

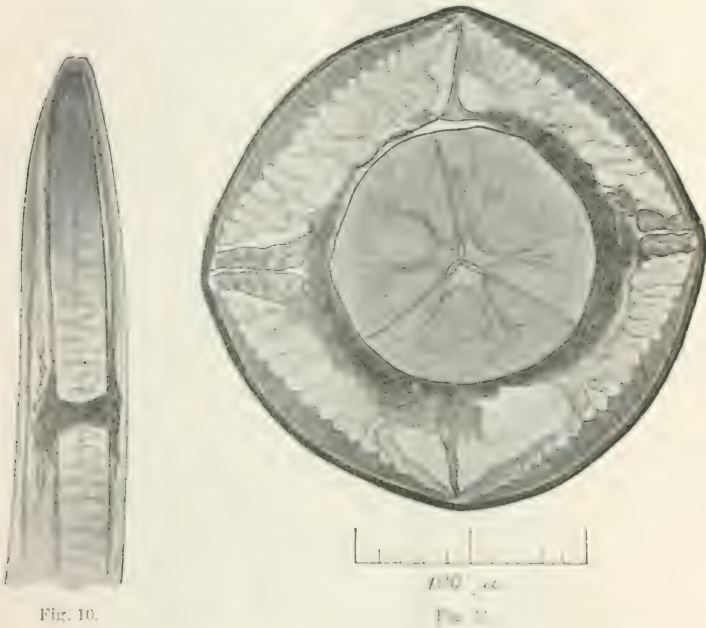


Fig. 10.

FIG. 10.—Enlarged view of the head, showing the central nervous system; the crossed condition of the fibers was quite evident in one specimen, but compared with other specimens this point in the drawing is somewhat exaggerated and diagrammatic.

FIG. 11.—Transverse section of head through region of the central nervous system. In addition to the characters described for fig. 5, note that instead of a bridge connecting the four longitudinal bands, there is a distinctly fibrillated structure which represents the central nervous system.

near the esophagus, but farther caudad it becomes somewhat flattened dorso-ventrally, so that its lateral diameter is about 308μ to a dorso-ventral diameter (closed lumen) of 202μ . The lumen is suppressed, or nearly so, and contains no food; the high, cylinder-epithelial cells are about 9μ broad; those near the median line are longer (in some cases attaining about 90μ) than those near the sides (which may decrease to 30μ); the nuclei of these cells are arranged near the distal end, namely away from the lumen, and measure about 6μ ; the cells themselves contain numerous particles, apparently representing reserve food material;

the cuticle of the lumen is 6.6 to 8.8μ thick, and in the posterior portion of the midgut this cuticle may show a rod-like structure. In the anterior quadrangular portion of the midgut, fibres run from the submedian corners toward the body wall.



FIG. 12.—Enlarged view of a midgut portion of a worm cleared in glycerine, as seen dorsally or ventrally. Note the following characters: The clear line in the middle represents the median line or band; near this is seen a fine mesh work which represents the surface view of the intestinal epithelium, as seen upon deep focus; above is a much coarser network, which represents the surface view of the reticulum (compare fig. 6) between the muscular layer and the intestine; the broad band, occupying more than half the figure, is the intestine; laterally of this there is on each side a dark band, representing the excretory glands; lateral of these are the areas of the lateral bands, with their nuclei; then the subcuticula, and finally the cuticle.

Rectum.—The rectum (figs. 7-9) is about 200μ long. Several large nuclei are visible in this region, and certain cell boundaries can be dis-

tinguished, but the details were somewhat unsatisfactory, owing to the condition of the material.

NERVOUS SYSTEM.—The brain (figs. 10, 11, 15) surrounds the esophagus at a plane corresponding rather closely to the excretory pore.

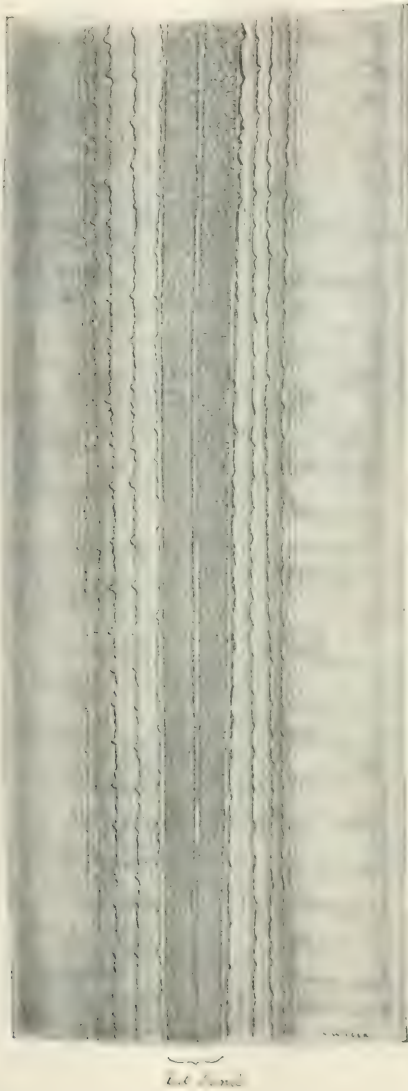


FIG. 13.—Enlarged lateral view of a midgut portion of a worm cleared in glycerine. Compare this with fig. 12, and notice the following details: The dark field in the middle is the lateral band (enlarged still further in fig. 14); this shows two parallel halves (dorsal and ventral), separated by a middle row of cells; the wavy, more or less parallel lines represent the somatic muscles; near the sides of the figure one obtains a lateral view of the large reticulum shown in fig. 12; on deep focus, this reticulum is, of course, much more distinct than can be shown in a view drawn in perspective.

namely, about 416μ from the anterior extremity. There is some slight variation in the different specimens, so that this measurement is some-

what diagrammatic and corresponds to an excretory pore 432μ from the cephalic end. A few cells, evidently ganglionic in nature, could be distinguished in the brain, but a detailed description of them would be difficult and rather unsatisfactory on the present material. Likewise a detailed description of the nerves would be likely to lead to errors of interpretation until fresh material can be found. It may be mentioned, however, that in one specimen in particular the fibers of the nerve ring seem to cross, as shown somewhat diagrammatically and in

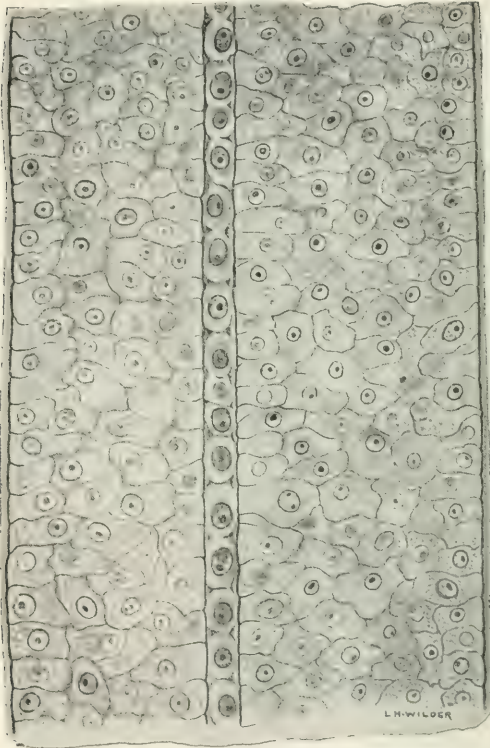


FIG. 14.—Very greatly enlarged lateral surface view of the lateral band of a specimen cleared in glycerine. Note the two halves (dorsal and ventral) of the band separated by a distinct line of cells; note also the nuclei and cells.

slightly exaggerated condition in fig. 10. At the submedian papillæ, and also in some other parts of the body, structures were observed which were strongly indicative of nerve elements, fibers, and ganglionic cells, but it is thought best not to describe them here and thus to avoid a danger of error of interpretation.

MUSCULAR SYSTEM.—

On examination of mounted specimens cleared in glycerine a marked longitudinal striation is visible on certain focus. This striation, rather wavy in character in many places, represents the somatic muscles. On transverse section (figs. 6, 11–14) these muscles are seen to be arranged in four distinct quadrants, separated

from each other by the four longitudinal lines. There are about 15 to 20 fibers per quadrant at about the cerebral plane, but in the equatorial plane there are many more—70 or more. These fibers are evidently quite long, but their length was not established. On cross section it is seen that the fibers in the submedian lines present the greatest radial diameter, while those nearer the longitudinal bands are smaller. The striation of the fibers is chiefly tangential to the worm, although occasionally a peripheral radial striation is noticed. The contractile substance of any given quadrant presents a notched or serrate appearance on its proximal border, and from the top of the

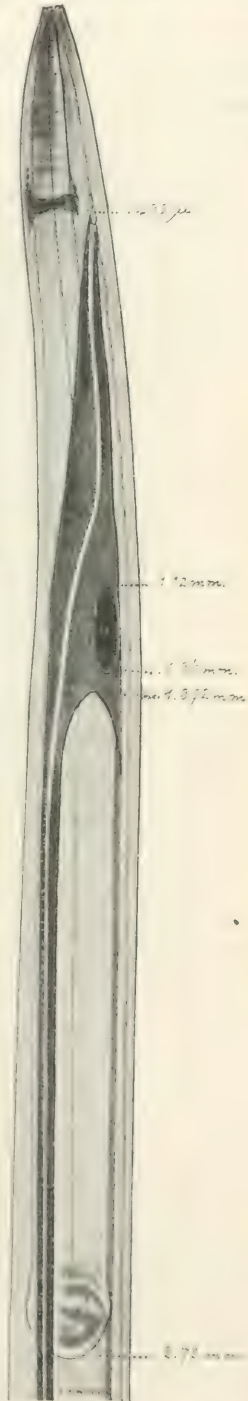
teeth of the serration centripetal fibers are noticed extending toward the intestinal tract. These centripetal fibers bound the protoplasmic processes of the muscle cells and form a mesh work which almost completely fills the body cavity and which gives a very striking picture as one views a mounted specimen cleared in glycerine. Because of the direction of the mesh work the dorsal and ventral views (fig. 12) of the worm, in respect to this mesh work, are entirely different from the lateral view (fig. 13). The superficial meshes are smaller than those which lie more deeply. The entire picture, as seen through the body wall, reminds one of adipose tissue. On transverse section, however, it is seen that fine fibers proceed from the apices of the serrate border of the muscular layer; these fibers extend in a general way toward the intestine, but in an irregular course. Approaching each other, they form small meshes near the muscle fibrillæ, with larger meshes toward the intestine. The smaller meshes near the muscle fibrillæ contain a finely granular mass; the larger meshes may be clear or nearly so. Nuclei may be observed here and there in the mesh work.

LONGITUDINAL BANDS AND SUBCUTICULA.—As stated in the foregoing, the lateral bands are much more highly developed than are the median bands; further, the lateral bands are in close relation to the excretory glands, so that the two together present an appearance which one is at first tempted to consider as indicating a common origin. Closer study, however, indicates a more distinct separation than at first seems probable.

Subcuticula.—The subcuticula is very thin, but in some sections, and even in some worms cleared in glycerine it appears quite distinct.

Median bands.—The median lines can be distinguished on most sec-

FIG. 13. Enlarged ventro-lateral view of esophageal region of a specimen cleared in glycerine, very slightly yellowed. The brain is situated 0.416 mm. from the anterior end; the excretory pore is immediately ventro-caudal of the brain; from the pore a canal can be traced on the non-nucleated side of the bridge; the two excretory glands dip ventrally and unite ventrally of the esophagus; laterally and somewhat anterior of their point of union, an enormous nucleus (210μ long) is visible; no canal is drawn on the nucleated side of the bridge. The measurements on the right give the distance of the points in question from the head.



tions (figs. 5, 6, 11). In most sections the median bands are seen to extend as very narrow structures centripetally beyond the muscle layer and then to become broader. In the esophageal region, especially anterior of the brain, they are more distinct than in the midgut region, and immediately back of the mouth they are connected with the lateral bands to form a suspensory bridge around the esophagus (fig. 5).

Lateral bands.—The lateral bands are much more complicated in structure than are the median bands. Very close to the mouth they are rather narrow (figs. 3, 5), extending centripetally, however, nearly to the esophagus. They may be more or less distinctly seen to be composed of two portions, one ventral, the other dorsal; each portion is supplied with distinct nuclei; farther caudad this division into a dorsal and a ventral portion is very apparent. Anteriorly, where the band is narrow, a lateral view of specimens cleared in glycerine shows two rows of nuclei directly under the cuticle—one row in the dorsal, the other in the ventral portion; on cross sections of this region not only are these two subcuticular nuclei visible, but in each portion a row of nuclei (fig. 5) is seen extending toward the esophagus.

Beside these two rows of nuclei, a third, at first less distinct, row of single subcuticular nuclei (figs. 3, 5) appears situated between the two more distinct rows and separating them; farther caudad, as will be shown below, this middle row becomes more distinct.

Centripetally of this middle row some sections seem to present a delicate but distinct longitudinal canal between the two (dorsal and ventral) halves of the lateral band. Whether this is an actual canal, as is indicated by the sections, or whether it is an artifact due to the material, may possibly be better left an open question for the present, for there are some sections in which the canal is not distinct, while in some sections which are torn the tear corresponds to this apparent canal. The sections in question can hardly form the basis for a strong argument against interpreting the structure in question as a canal, for the latter is a delicate structure, the lumen of which might easily be suppressed at some points, while any tear of the section would rather naturally occur at this point.

Farther caudad, for instance in the midgut region of the body, the lateral band presents a very striking appearance (figs. 13, 14). On examination of specimens cleared in glycerine the lateral view shows broadened dorsal and ventral halves, in which a distinct subcuticular cellular structure is evident; each cell presents a nucleus. While these nuclei are seen at almost any point, they appear more distinct and more regular near the margins of each half. The middle single row of cells becomes very distinct, separating the dorsal and the ventral halves of the band.

Sections (figs. 16 to 25) confirm the surface views, and show certain additional characters. There are two quite distinct thickenings of the cuticle at the lateral band, near the lateral line. The dorsal and the ventral halves of the lateral band are seen to vary considerably in transverse outline as sections are followed caudad, and the two halves are not symmetrical, one to the other. The nuclei are seen to be more massed and more numerous near the dorsal and ventral margins of each half than between these points; most of the nuclei are situated centrifugally (distally), but here and there nuclei are found some distance proximally (away from the cuticle); further, cellular prolonga-

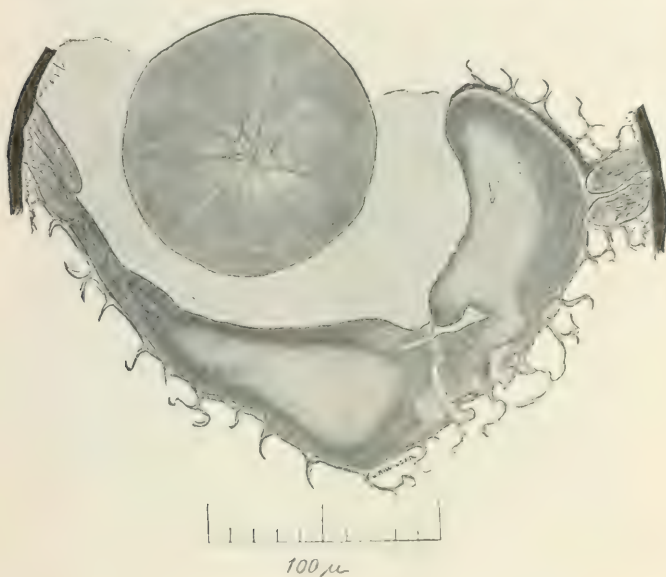


Fig. 16.

FIGS. 16-25.—Nine transverse sections of the lateral band and the excretory gland in different parts of the body, except that figs. 19 and 20 and figs. 21 and 22, represent the two glands on opposite sides of the same cross sections. Fig. 16 is anterior of the nucleus and shows a bladder-like widening (*ex. c.*), apparently belonging to the excretory canal. Fig. 17 is through the nucleus. Note the excretory canal (*ex. c.*) on the nonnucleated side. Dorsally of the nucleus is a thick-walled canal-like structure. The nucleus is somewhat contracted from the nuclear membrane. Fig. 18 is a section caudad of the point of union of the bridge. Figs. 19-20 show the two lateral bands and two glands from one section. Note their asymmetry. Figs. 21-22 show the two lateral bands and glands further caudad. Fig. 23 shows a section in which the gland has reduced in cross section and exhibits a reticular structure. Fig. 24 shows a section still farther caudad. Fig. 25 shows a section near the caudal end of the gland. The latter is very small.

tions are seen to extend centripetally, toward the proximal margin of the lateral band; in some cases these cells were followed nearly or quite to the proximal margin; in some sections there appeared to be a decidedly distinct differentiation in the proximal (centripetal) portion.

indicative of a lack of distinct cellular structure; whether this differentiation was an artifact, and more apparent than real, due to the condition of the material, may better be left for decision when fresh material can be examined. The dorsal, ventral, and proximal margins of each half of the band present a condensed appearance which in not a few sections is indicative of a distinct membrane.

Toward the lateral line, corresponding to a frontal plane of the worm, the dorsal and ventral halves of the lateral bands are distinctly separated. This separation is due primarily to the single, middle row of cells mentioned above. The nuclei of these cells can be very distinctly seen both on surface views and on section, but it is more diffi-

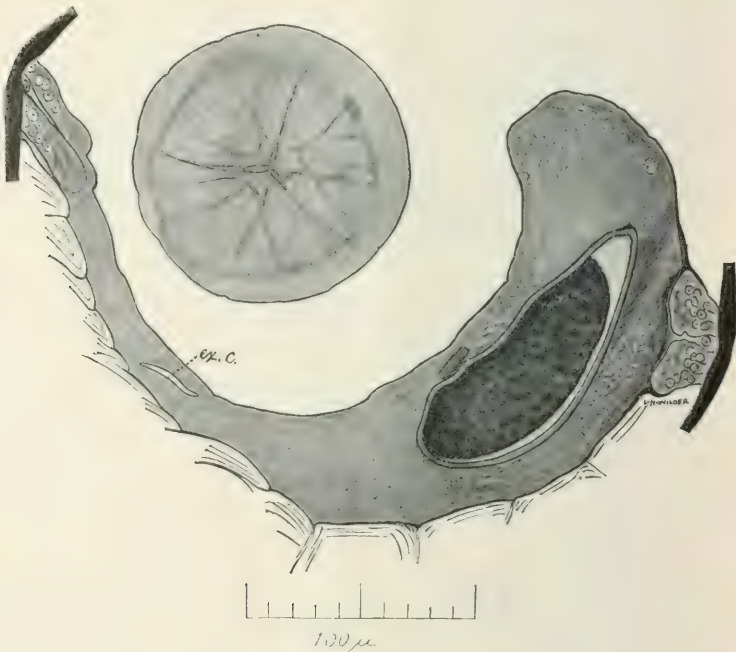


Fig. 17.

cult to trace the centripetal portion of the cells themselves. In some sections the cells could be quite distinctly followed to the proximal borders of the two halves of the band, namely to the point at which the gland (to be described below) meets the marginal point between the two halves of the band. The picture obtained was strongly indicative of an interpretation that the middle row of cells in question acted as a connective element between the gland and the subcuticula. Such an interpretation was not confirmed, however, by some of the sections, for the cell could not be traced to the proximal margin, and the space not occupied by the cell appeared not unlike a canal; the possibility is by

no means excluded that this canal-like appearance was an artifact: in fact, certain sections strongly indicated that it was. In still other sections, the middle cell was rather short, but a process from the large gland could be followed centrifugally between the dorsal and ventral halves of the band, nearly or quite to the middle cell.



Fig. 18.

The determination of the existing conditions must be left for study of fresh material, notwithstanding a strong indication on some surface views of the existence of a longitudinal canal with a lumen of about 4 to 6 μ in diameter.

EXCRETORY SYSTEM.—The excretory system is very striking, but only a part of it can be interpreted at present.

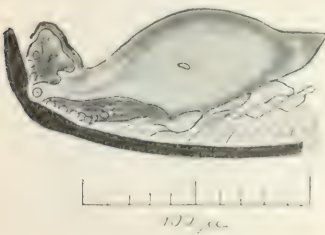


Fig. 19.

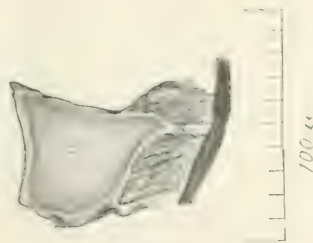


Fig. 20.

On surface views of worms cleared in glycerine a large, longitudinal ridge, of somewhat sinuous outline longitudinally, is seen on each side of the body, in close relation to the lateral bands. On transverse sections several prominent characters of this ridge are distinctly visible. In the first place it is seen that in any given section the transverse outline of the two ridges may be entirely different (compare fig. 19

with fig. 20, and fig. 21 with fig. 22); this fact is easily explained by the sinuous character noticed on surface views. Independent of this variation between the two ridges of any given transverse section, there is a marked difference in the transverse outline of the gland in different parts of the body. This outline is to some extent correlated with the transverse outline of the lateral bands, for, in general, when the bands are low radially the gland is likely to be large, while when the gland is small the bands are likely to be larger radially. The gland may be followed into the posterior portion of the body, where it becomes very small; toward the esophageal portion of the body, it becomes larger and more prominent.

Another point visible on transverse section is the presence of a distinct canal in about the center (axial line) of each gland; although some sections were found in which this canal was not distinguishable, it was distinct in so many sections that its existence can hardly be questioned.

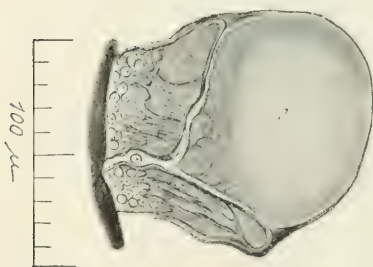


Fig. 21.

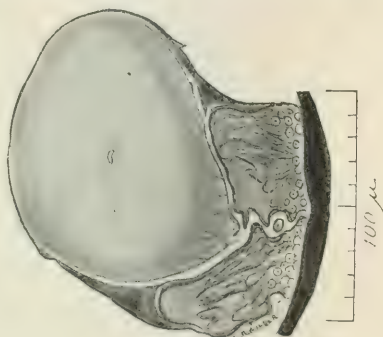


Fig. 22.

In some sections, the gland appeared granular, in others it was more distinctly reticulate in appearance.

Surface views of the middle (equatorial) esophageal region (fig. 15) show that the two longitudinal glandular ridges dip ventrally and unite to form a bridge; the united structure can then be traced cephalad nearly or quite to the excretory pore; one canal also is seen to dip ventrally and can be traced to the excretory pore; the natural expectation is that the two canals (one from each side) unite before reaching the pore; on surface views the point of union was not recognized. On sections the excretory pore was confirmed; almost directly dorsally of it were at least two (possibly several) cells, each with a distinct nucleus; tracing the excretory canal caudad it is seen to possess for a short distance a rather thick cuticle; suddenly the wall becomes thin and the canal *seems* to broaden into a larger cavity resembling a bladder (fig. 16); several of the following sections are unsatisfactory, but the canal can be traced on the nonnucleated side (see below) of the bridge

until it reaches the vicinity of the lateral bands, corresponding to what was observed in two worms cleared in glycerine (fig. 15). On the nucleated side of the bridge the study was less satisfactory, but dorsad of the nucleus a thick walled canal-like structure was observed in several sections (fig. 17).

On surface views a large, distinct, and rather remarkable nucleus is also visible; this is situated slightly cephalad of the point of union of the glands and appears to be unilateral; at least, in no specimen, either on surface view or in section, could two such nuclei be distinguished. This fact, that only one nucleus could be found, is strongly indicative of an interpretation that the two glands together represent in reality only one cell. As the nucleus found was very distinct, it is difficult to assume that the absence of a second nucleus was due to the condition of the material.

This nucleus varies slightly in shape, but, in general, it is much longer than broad; it may attain a measurement of 296 to 316 μ long (parallel with longitudinal axis of body) by 90 to 132 μ broad (trans-

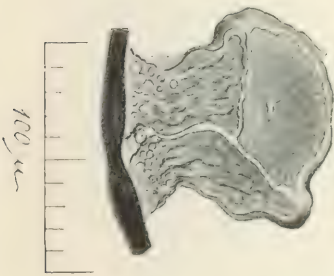


Fig. 23.

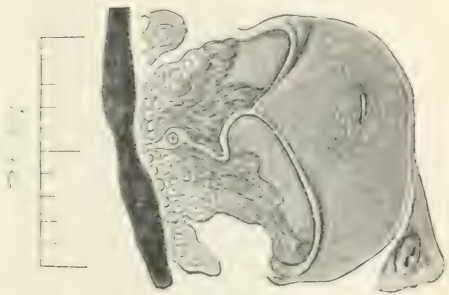


Fig. 24.

verse to longitudinal axis of body). Both in mounts of the entire worm and in sections, the nucleus presents a thick nuclear membrane and a content of exceedingly large granules. Its appearance is very suggestive of the large nuclei of the cephalic glands of *Agelhylostomus duodenale* (see especially Looss, 1905, figs. 5 and 38).

From the foregoing description it will be seen that the glandular structures do not correspond closely, so far as could be observed, with the conditions described by Looss (1905) for *Agelhylostomus duodenale*. While recalling the unsatisfactory condition of the material, it is seen that no true distinct systems of cephalic and cervical glands have been observed, and that what would seem to correspond to the head glands of *Agelhylostomus duodenale*, judged from their position in respect to the lateral bands, and from the large nucleus, appear to discharge through the excretory pore; further, that the two sides of the animal are not symmetrical in respect to these structures. Further study is, of course, advisable on material in better condition.

The ridge does not necessarily extend directly at right angles to the median line of the lateral bands, but may fall toward the median surface lines of the body; thus, in an examination of a worm mounted whole, one may focus superficially upon the margins of the true lateral band and then more deeply upon the displaced margin of this ridge; such change of focus gives an impression that the lateral band is broader than it really is.

A *longitudinal canal* may be seen in transverse sections of this ridge. This canal can be traced on sections caudad practically to the caudal end of the ridge; in tracing it cephalad, some sections were found in

which the canal could not be distinguished with certainty, but in the majority of the sections it was visible.



Fig. 25.

Even from this rather incomplete description, it is seen that the ridge is not an integral part of the proliferation of the subcuticula which forms the lateral bands *s. str.*, but rather an organ of glandular appearance, reminding the observer of the so-called cephalic gland, described in certain nematodes.

GENITAL ORGANS.—In no specimen were structures found which could be positively interpreted as representing genital organs. One would naturally assume that in an animal of this size there must be such organs present in at least an early stage of development. Probably they are present, although they could not be recognized.

BODY CAVITY. —The body cavity is almost completely occupied by the intestine, lateral ridges, and the mesh work extending inward from the muscular layer. In addition to these structures a considerable amount of more or less coarsely granular material was found; in at least one instance a granular structure (?? primordium of the genital organs) was found unilaterally, close to the lateral band near the posterior end of the chyle intestine.

THE ZOOLOGICAL CHARACTERS OF THE ROUNDWORM GENUS *FILARIA* MUELLER, 1787, WITH A LIST OF THE THREAD WORMS REPORTED FOR MAN.

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Chief of Division of Zoology, Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service.

(Figs. 26-34.)

Of the zoological names used by physicians, the generic name *Filaria* is one of those most commonly quoted. As used both by zoologists and by physicians, this name has been made to act as a generic catch-all for slender roundworms which could not be definitely determined.

Recently an apparently new species of roundworm (*Agramofilaria georgiana*) from a superficial sore on the ankle of a negress was sent to me by Dr. St. J. B. Graham, of Savannah, Ga., for determination, and upon trying to classify it I found that it could easily be placed in the genus *Filaria* as generally understood. From a systematic viewpoint this was unsatisfactory, and this fact led me to trace the history of the genus *Filaria*. The results obtained have a bearing upon the parasites of man and part of them are herewith published in the hope of aiding to clear up this group of parasites, so little understood zoologically despite the enormous amount of literature which has appeared upon the subject.

The genus *Filaria* was established in 1787, by Mueller. In the original publication Mueller did not mention any specific names, but he referred to a number of parasitic worms in various animals, and comparing his bibliographic references with Gmelin, 1790a, it is clear that he classified the following worms in his new genus:

A. In mammals:

1. *Filaria leonis* Gmelin, 1790a; this form has been viewed since 1809 as a species inquirenda.
2. *F. leporis* Gmelin, 1790a; this form has been viewed since 1809 as a species inquirenda.
3. *F. martis* Gmelin, 1790a; of the three original filariae of mammals, this species alone has been found and described on several occasions since 1790. It apparently contained two species. Of these, *Filaria mustelorum* [*pulmonalis*] has been separated as the type of *Filaroides*, and the remaining form has been renamed *Filaria mustelorum subcutanea* 1819, *F. quadrispina* 1851, and *F. perforans* 1858.

B. In birds:

4. *F. gallinae* Gmelin, 1790; eliminated from *Filaria* since 1803.

5. *F. falconis* Gmelin, 1790a; considered identical with either *F. forcolata* 1858, or with *F. nodispina* 1858.

6. *F. ciconiæ* Gmelin, 1790a; incompletely known, possibly identical with *Dicheilonema labiatum*.

C. In insects: Eight species belong here, but it is clear that Mueller intended to separate them from *Filaria*.

Of the species mentioned above, it is clear that either *martis* or *falconis* should be taken as type of *Filaria*, and as circumstances distinctly favor *martis*, this was designated type by Stiles & Hassall (1905, 106). Accordingly, *Filaria martis* must be studied in order to determine what the genus *Filaria* represents.

Filaria martis was originally described, but not named, by Redi. It occurs in the pine marten (*Mustela martes*) and several other animals, in Europe. The form which occurs in Europe in the pine marten should be taken as the standard of reference. This worm has been found by several authors; it has been renamed several times, but, unfortunately, its anatomy is not very well studied. No specimen is at my disposal at present, but from the accessible literature it may be seen that the parasite presents the following synonymy, bibliography, and zoological characters:

FILARIA MARTIS Gmelin, 1790.

[Figs. 26 to 34.]

1790: *Filaria martis* Gmelin, 1790a, 3040 (ex Redi).—Bosc, 1802a, v. 2, 48; 1830a, v. 2, 59.—Diesing, 1851a, 272 (syn. of *F. quadrispina*).—Molin, 1858, 387 (syn.



Fig. 26.

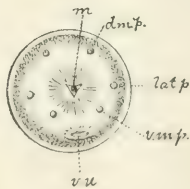


Fig. 27.



Fig. 28.



Fig. 29.

FIG. 26.—Anterior end of female *Filaria martis*, from *Mustela martes*, Italy; a, mouth. Enlarged. (After Alessandrini, 1838, pl. 1, fig. 1.)

FIG. 27.—View of anterior end, en face: m, Mouth; dm. p., dorso-submedian papilla; lat. p., lateral papilla; vm. p., ventro-submedian papilla; vu., vulva. Enlarged. (After Schneider, 1866a, pl. 5, fig. 9.)

FIG. 28.—Tail of female. Enlarged. (After Alessandrini, 1838, pl. 1, fig. 4.)

FIG. 29.—Tail of male, showing spiral and spicule. (After Alessandrini, 1838, pl. 1, fig. 2.)

of *F. perforans*); 1858, 167 (syn. of *F. perforans*).—Ransom, 1904, 31.—Rudolphi, 1809a, 69 (renamed *F. mustelarum*); 1810a, 379.—Stiles & Hassall, 1905, 106 (type of *Filaria*).—Stossich, 1897, 33 (syn. of *F. quadrispina* Dies-

ing); 1898, 95 (syn. of *F. quadrispina* Diesing).—Zeder, 1803a, 38 (ex Redi; sub cute, *Mustela martes*).

1794: ?*Filaria medinensis* Rosa, 1794, 2 (not accessible to me).—Diesing, 1851a, 272 (as doubtful syn. of *F. quadrispina* Diesing).—Molin, 1858, 387 (as doubtful syn. of *F. perforans*); 1858, 164, 167 (in *Mustela foina*, sub cute; as syn. of *F. perforans*).

1809: *Filaria mustelarum* Rudolphi, 1809a, 69, misprint for *Filaria mustelarum*, q. v.

1809: *Filaria mustelarum* Rudolphi, 1809a, 69 (includes Redi, 24, 25, pl. 9, fig. 3, vers. p. 34; and *F. martis* Gmelin, 1790a, 3040; infra pellem et inter musculos *Mustelæ foinæ, martis, et putorii*, Redi); 1810a, 379–380.—Alessandrini, “1843, 530.”—Bosc, 1830a, v. 2, 59.—Diesing, 1851a, 272 (syn. of *F. quadrispina*); 1857a, 18 (13).—[Dujardin, 1845a, 47].—Molin, 1858, 387 (syn. of *Filaria perforans*); 1858, 166, 167.



Fig. 30.



Fig. 31.

Fig. 30.—Tail of male, flattened to show the alae. Enlarged. (After Alessandrini, 1838, pl. 1, fig. 3.)

Fig. 31.—Tail of male, ventral view, showing alae, spicules, and papillae. Enlarged. (After Schneider, 1866a, 86.)

1819: *Filaria mustelarum subcutanea* Rudolphi, 1819a, 7, 216 (*F. mustelarum* Rudolphi, 1809, renamed; sub cute *Mustelarum foinæ, martis, et putorii*).—Alessandrini, 1838, 1–17, pl. 1, figs. 1–12 (in *Mustela foina*).

1846: *Filaria mustelæ foinæ* Creplin, 1846b, 161.

1850: *Filaria quadrispina* Diesing, 1851a, 271–272 (includes Redi, 24, 25, pl. 9, 3, vers. 34; *F. martis* Gmelin, 1790a; *F. medinensis*? Rosa, 1794, 2; *F. mustelarum* Rudolphi, 1809a; in *Mustela foina*, *M. putorii*, *M. martes*; sub cute et inter musculos, Europe).—Molin, 1858, 387 (syn. of *F. perforans*); 1858, 165, 166, 167, 168 (syn. of *F. perforans*).—Parona, 1896, 6.—Schneider, 1866a, 85–86, 1 fig., pl. 5, fig. 9 (in *Mustela martes* and *Hystrix cristata*, under the skin).—Setti, 1897, 48–49 (in *Mellivora capensis*; Ghinda).—Stossich, 1890, 11 (in *Mustela foina*); 1890, 56; 1893, 3; 1896, 122 (4, fig. 17); 1897, 32–33; 1898, 95 (in *Mustela foina*; at Trieste, Cittanova); 1902, 11 (in *Mellivora capensis*; Ghinda (Eritrea), N. E. Africa).

1858: *Filaria perforans* Molin, 1858, 387 (includes Redi, 24, 25, pl. 9, 3, vers. 34; *F. martis* Gmelin, 1790a; *F. medinensis*? Rosa, 1794; *F. mustelarum* Rudolphi, 1809a; *F. quadrispina* Diesing, 1851a; *F. mustelæ barbae* M. C. V.; in *Mustela foina*, *M. putorius*, *M. martes*, sub cute inter musculos; and *Gulo barbatus*, in

cavo thorac., Ypanema); 1858, 155 (in *Mustela foina*; Padua); 1858, 161-170; 1861, 316-318, pl. 14, figs. 7-8 (supposed young stage, encysted).—Blanchard, 1890a, 3.—Diesing, 1861a, 700; 1861c, 280.—Grassi, 1887g, 622.—Parona, 1887, 495 (in *Mustela foina*; Genova Zool. Mus.); 1894, 240; 1896, 6 (in *M. foina*).—Setti, 1897, 48 (syn. of *F. quadrispina* Diesing).—Stossich, 1898, 95 (syn. of *F. quadrispina* Diesing).

1858: ? *Filaria mustelæ barbaræ* M. C. V. Collect. Brasil. in Molin, 1858, 387 (syn. of *F. perforans*).

1858: ? *Filaria mustela barbata* Molin, 1858, 168, for *F. mustelæ barbata*.

1894: "*Filaria subcutanea*?" in Parona, 1894, 240.

SPECIFIC DIAGNOSIS.—*Filaria* (p. 36): Body white, slender, filiform, very long, subequal; anterior extremity attenuated, obtuse; posterior extremity very attenuated, more so than head. Cuticle without a trace of transverse striation (Alessandrini, 1838). Mouth small, round, unarmed, surrounded by 4 submedian noduliform papillæ; in the female the ventro-submedian papillæ are somewhat nearer the mouth than are the dorsal (Schneider); in the male the papillæ are somewhat displaced (Stossich).

Male: 73 mm. long (2 to 3'' by $\frac{1}{8}$ to $\frac{1}{4}$ '''). Caudal extremity forms a spiral; provided with broad cuticular alæ (bursa) which meet terminally; with 9 pairs of ventral filiform papillæ, 3 pairs preanal, 6 pairs postanal: 1 and 2, 3 and 4 close together; 5 and 6 near the median line (Schneider). Spicules unequal: the larger spicule in form of a tube, with broad, transversely striated alæ; the shorter spicule conical.

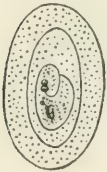


FIG. 32.—Egg.
Enlarged.
(After Stossich, 1896.)

Female:^a 190 mm. long (4 to 7'' by $\frac{1}{4}$ to $\frac{1}{2}$ '''). Caudal extremity acuminate, somewhat curved ventrad; "anus at apex" (Alessandrini). Vulva anterior, very close to the mouth, almost terminal. Viviparous (Molin); ovoviviparous (Alessandrini).

Eggs: Very numerous, small, elliptical, with very thick shell and covered with very minute granulations (Stossich).

HABITAT.—Under the skin, and elsewhere, of various European Carnivora: Pine Marten (*Mustela martes* Linnaeus); Beech Marten, Stone Marten, or White-breasted Marten (*Mustela foina*); Common Polecat (*Putorius putorius*); Common Porcupine (*Histrix cristata*); the Ratel (*Melivora capensis*=*M. ratel*). Also reported for one American host: Tayra (*Gulo barbatus* Desm.=*Mustela barbara* Linnaeus=*Galictis barbara*=*Galora barbara*) [legitimate doubts may arise regarding the specific identity of the Brazilian parasite^b with the European form].

GEOGRAPHIC DISTRIBUTION.—Italy, Austria, Eritrea (Africa), and ? Brazil.

^aIn referring to filariæ "des martes et des putois," Dujardin (1845a, 48) says that a filaria sent from Vienna to the Paris Museum in 1816, and labeled as having been found under the skin of a marten is a female, 170 mm. long, by 0.4 mm. in diameter, with a head 0.10 mm. in diameter, obliquely truncate, and with a very small round mouth near the margin; its tail is equally obtuse, 0.07 mm. broad. The eggs, with which this helminth is filled, are elliptical, nearly round, 42 μ long, covered with a caducous granular layer, and show an enrolled embryo. "It is very probable from these characters that it should be placed in another genus."

^bMolin (1858, 168) examined a female taken by Natterer in Brazil from the thoracic cavity of *Gulo barbatus*, and states: "Questo corrispondeva esattamente alla descrizione che ho dato delle Filarie sottocutanee delle martore; soltanto la sua estremità caudale era molto ottusa. Esso misurava 6'' in lunghezza, e $\frac{1}{2}$ ''' [= '''] in larghezza."

Molin (1861, 316-318, pl. 14, figs. 7-8) describes a young encysted worm which he interprets as the young stage of *F. perforans*. This interpretation is, as Molin indicates, subject to confirmation. His account is here given in the original, as the work in which it was published is not generally accessible:

HABITACULUM.—*Mustela putorius*: sub cute et in tela conjunctiva intermusculari, omni anni tempore. *M. foina*: sub cute et in tela conjunctiva intermusculari, omni anni tempore; inter pericardium et cor, in corde sub endocardio, in cavo thoracis et abdominis, et sub cute, Decembre, Patavii (Molin).

Osservazione 1. Ad ogni epoca dell' anno rinvenni numerosi esemplari tanto maschi che femine del suddetto verme sotto la cute e fra i muscoli delle pazzole e delle faine, specialmente presso alle scapule ed al capo del femore.

Al 31 di Decembre 1857 ricevetti 2 grandi faine. In una di queste rinvenni una filaria perfettamente sviluppata ravvolta intorno agli atri del cuore sotto il pericardio, ma nessun verme sotto la cute. Nell' altra invece ritrovai parecchie filarie sotto la cute e due piccole sopra il peritoneo nella regione delle coste spurie, le quali avevano di già perforato la cavità addominale e passavano dall' altra parte per annidarsi sotto la cute. Nella prima faina però oltre alla filaria intorno al cuore rinvenni l' omento e la faccia esterna dello stomaco tempestati da piccole vescichette del diametro di circa 0.001 ciascuna delle quali conteneva, oltre un fluido nel quale nuotavano dei corpuscoli simili a cellule, un vermetto attortigliato della lunghezza di circa 0.003. Già per lo innanzi avevo riscontrato due volte sul peritoneo delle faine due o tre piccole vescichette con entrovi lo stesso verme. Nella faina nella quale trovai vescichette sull' omento, ne rinvenni una ma molto più piccola nella camera destra del cuore sotto il pericardio. Essendo esse abbastanza trasparenti, ne posi alcune sotto al microscopio dopo d'averle un momento compresse. Ed osservando attentamente ho potuto assicurarmi che il verme contenutovi era vivo e si moveva.

Osservazione 2. Fatte scoppiare le vescichette mediante una compressione più forte, ne sortì il verme, il quale sotto un forte ingrandimento mostrava il corpo pressochè cilindrico, un momento attenuato all' innanzi e obliquamente tronco non che acuminato all' estremità caudale. Egli aveva all' estremità anteriore la apertura della bocca circondata da tre piccolissime papille, e il margine inciso ad angolo in un punto. Dall' apertura della bocca partiva la faringe corta ed angusta la quale si dilatava nello stomaco circa quattro volte più largo e lungo un terzo del corpo. Dallo stomaco fino all' ano, collocato in fianco un poco all' innanzi dell' apice caudale, estendevasi il budello un po' più angusto. Dallato del budello potei distinguere un altro tubo molto esile, il quale ricorda gli organi genitali interni della *Filaria perforans*. Lo stomaco era troppo opaco per poterne studiare l' istologia; ma tanto il budello che l' altro tubulo vicino sembravano composti di piccole cellule poligonali collocate a musico una presso l' altra. Da questa circostanza credetti poter concludere che questi vermi erano ancora in uno stadio remoto di sviluppo. Confrontati questi vermi colla *Filaria perforans* sembravano identici, meno le papille intorno alla bocca. Forse questi saranno organi, i quali vanno perduti, ovvero si modificano coll' incremento dell' animale. Dal complesso di queste osservazioni credo però che facilmente risulti che la prole delle filarie entrano nelle cavità del



Fig. 33.—Supposed young, encysted stage of *F. martis*: a, Transparent cyst; b, internal membrane; c, coiled worm; d, head; e, tail; f, stomach. Enlarged. (After Molin, 1861, pl. 14, fig. 7.)

corpo, che quà si sviluppano i giovani vermi, i quali arrivati a certa grandezza perforano dall' interno all' esterno le pareti del corpo per annidarsi sotto la cute. Quali sieno le loro peregrinazioni ulteriori, come arrivino a depositare le uova nella cavità addominale, sono questi importanti bensì ma tali che soltanto qualche osservazione accidentalmente fortunata sarà in istato di sciogliere. Io ho creduto necessario il pubblicare questi fatti affinché possano servire di traccia a qualche altro investigatore.

Osservazione 3. Ho voluto dare un' imagine tanto del verme nella vescichetta che isolato.

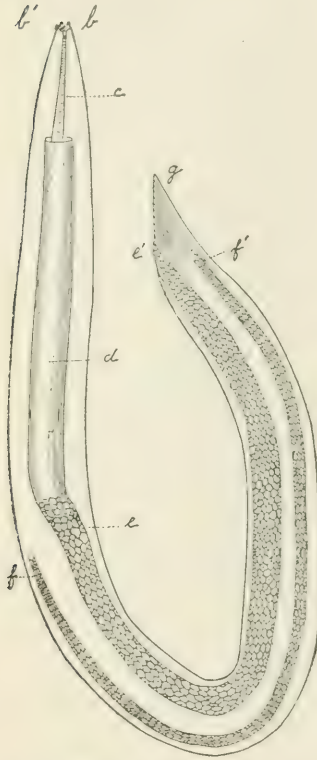


FIG. 34.—Worm freed from its cysts: *a*, Mouth; *b*, *b'*, papillae; *c*, "pharynx;" *d*, "stomach;" *e*, *e'*, intestine, with polygonal cells; *f*, *f'*, genital organs; *g*, tail. Greatly enlarged. (After Molin, 1861, pl. 14, fig. 8, reduced to two-thirds of original figure.)

Any generic diagnosis written for the genus *Filaria* should contain the major characters given above (p. 34) for *Filaria martis*. This species, which does not appear to be rare, should be carefully restudied for other characters; some characters of striking nature are almost positively absent from *F. martis*, otherwise authors would doubtless have mentioned them. While it is impossible to write a detailed diagnosis for *Filaria* until the type species is restudied, we are now in a position to determine some of its most important characters; and these we may safely take as minimum characters for a type subgenus *Filaria* (*Filaria*), even if not for the genus *Filaria*.

Subgenus FILARIA Mueller, 1787.

- 1787: *Filaria* Mueller, 1787, 64–67 (type by elimination, *F. martis* Gmelin, 1790, in subcutaneous tissue of *Mustela martes* of Italy); from *filum*, a thread.
 1809: *Filaria* Rudolphi, 1809a, 69, misprint
 1840: *Filaire* Lee, 1840a, 283, misprint.
 1877: ? *Wuchereria* Silva Araujo, 1877, Nov., 492, 504, mentioned as *Wuchereria filaria* possibly a lapsus for *Filaria wuchereria*.
 1877: *Filaria* Magalhães, in Silva Lima, 1877, Dec., 544, misprint.
 1884: *Filaria* Calmette, 1884a, 459, misprint.
 1904: *Falaria* Leidy, 1904a, 190, misprint.

SUBGENERIC DIAGNOSIS.—*Filaria*: Very long, filiform worms. Cuticle unstriated (Alessandrini) and evidently without bosses. Mouth small, round, unarmed, terminal, without lips.

Male: Shorter than the female; tail forms a spiral, and is provided with lateral cuticular alae and with both preanal and postanal, filiform, papillae, spicules unequal.

Female: Vulva anterior, very close to the mouth.

TYPE-SPECIES.—*Filaria martis* Gmelin, 1790.

While it is to be regretted that the present anatomical knowledge does not permit a more complete diagnosis, the characters given above furnish us a certain amount of valuable information in regard to the necessity of excluding from the typical *Filaria* certain other worms, usually classified as members of this genus.

A large number of different species of *Filaria* have been described. Of these, the following species have been taken as types of distinct genera:

- æthiopica* Valenciennes, 1856, see *medinensis*.
- anthuris* Rudolphi, 1809a (*Acuaria* Bremser, 1811; *Anthuris* Rudolphi, 1819; *Spiroptera* Rudolphi, 1819; *Dispharagus* Dujardin, 1845).
- bourgii* see *loa*.
- caudispina* Molin, 1858 (probably type of *Dipetalonema* 1861).
- conjunctivalis* Penel, 1905, see *loa*.
- cystica* Salisbury, 1868, see *Ocyuris* (*Ocyurias*) *vermicularis*.
- diurna* see *loa*.
- dracunculus* see *medinensis*.
- hominis* Diesing, 1851a (equals *lymphatica* renamed, type of *Hamularia*).
- hominis bronchialis* see *hominis*.
- irritans* Rivolta, 1884 (*Dermofilaria* Rivolta, 1884).
- labiata* Creplin, 1825a (? type of *Dicheilonema* 1861).
- loa* Cobbold, 1864 (*Loa* Stiles, 1905).
- lymphatica* Treutler, 1793 (*Hamularia* Treutler, 1793).
- medinensis* Linneus, 1758a (*Dracunculus* 1759).
- megalochila* Diesing, 1851a (*Schizoeilonema* and *Tricheilonema* Diesing, 1861a).
- musæ* Carter, 1861d (*Habronema* 1861).
- mustelarum* (pulmonalis) Rudolphi, 1819a (*Filaroides* Beneden, 1858a).
- oculi* Gervais & van Beneden, 1859b, see *loa*.
- physalura* Bremser, 1851 (? type of *Monopetalonema* 1861).
- quadrilabiata* Molin, 1861 (*Tetracheilonema* 1861).
- rigida* Siebold, 1836 (*Bradynema* zur Strassen, 1892).
- subconjunctivalis* Guyon, 1865a, see *loa*.

In connection with the genus *Filaria*, and to some extent in addition to the genera just mentioned, certain other groups come into consideration. Reference is made to the genera which Diesing, 1861a,^a included in his family *Spiruridea*, namely, the following sub-families:

1. *Acheilospiruridea*, with the genera *Spiroptera*, *Eucamptus*, *Proleptus*, *Histioccephalus*, *Dispharagus*, *Spiropterina*; and
2. *Cheilospiruridea*, with the genera *Spirura*, *Hystriehis*, *Echinocephalus*, *Cheilospirura*, and *Physocephalus*.

In reference to *Spiroptera*, it may be noticed that the following species have been made types of genera:

- anthuris* Rudolphi, 1819a (*Acuaria* Bremser, 1811; *Anthuris* Rudolphi, 1819; *Spiroptera* Rudolphi, 1819; *Dispharagus* Dujardin, 1845).
- hamulosa* Diesing, 1851a (*Cheilospirura* Diesing, 1861).

^aThis paper was presented to the Academy on December 6, 1860, but does not appear to have been published until 1861. It is erroneously given as December 6, 1861, in Stiles & Hassall's Index Catalogue of Medical and Veterinary Zoology.

laticaudata Rudolphi, 1819a (? type of *Histiocephalus* Diesing, 1851).
scutata Mueller, 1869 (*Myzomimus* Stiles, 1892).
contorta Rudolphi, 1819a (*Spiroxys* Schneider, 1866).

Beside all the genera thus far mentioned, a zoological revision of the threadworms must also take into consideration certain other genera, such as *Physaloptera* (which some authors classify in the *Filaridae*, others in the *Strongylidae*, others as a distinct family), and several other genera, the systematic position of which is not definitely established. *Thelazia* Bosc, 1819, based upon *T. rhodesii* (compare *lacrymalis*) of cattle, must be considered in this connection.

Without attempting at present to revise the entire filaria group, which should probably be given superfamily rank, as *Filarioidea*, it is possible, in light of the type *Filaria* as now determined, to classify, to at least some extent, the threadworms reported for man. At least two subfamilies should be recognized for these worms, namely, *Dracunculinae* and *Filariinae*.

Superfamily FILARIOIDEA new group.

Family FILARIIDÆ Braun, 1895.

- 1863: *Filaridea* Carus, 1863, 461.
 1876: *Filaridea* Leuckart, 1876a, 609-611.—Braun, 1883a, 160, 181.—Parona, 1887, 358.
 1879: *Filaride* Cobbold, 1879b, 5.—Blanchard, 1895, 746.—Bos, 1894a, 218.—Braun, 1895b, 219.—Daniels, 1898e, 879-880.—Lepri, 1898a, 56.—Roger, 1901, 95.—Schneidemuehl, 1896, 306.—Stossich, 1898, 92.
 1895: *Filaridea* Braun, 1895b, 212-213.—Ransom, 1904, 20, 30, 31, 38, 40, 41.—Shipley, 1896, 147.
 1899: *Filarides* Assenova, 1899, 104.

It is very difficult at present to write a satisfactory diagnosis of this family, but the following may be taken provisionally for this purpose:

FAMILY DIAGNOSIS.—*Nematoda*, *Filarioidea*: Body filiform, rather long, in some cases about a meter in length. Head straight, often, if not always, with two latero-median and four submedian papillæ; lateral lines more highly developed than median lines. Mouth terminal, variable, in some cases with two lips, occasionally with a more or less distinct buccal capsule; esophagus slender, elongate, may be divided into two portions, but has no posterior bulb; midgut present; rectum present; anus subterminal. All species parasitic. Development, at least in certain species, with change of host.

Male: With 1 to 2 unequal spicules; tail usually curved spirally, provided with papillæ, and in some cases with lateral ake.

Female: Larger than male; vulva present or absent in gravid worms; when present, usually anterior; uterus double; usually ovoviviparous.

TYPE GENUS.—*Filaria* Mueller, 1787.

This family contains numerous species which have been placed in rather poorly defined genera.

There can be little doubt that the *Filaridae* must be divided into several subfamilies. The typical subfamily will necessarily be *Filariinae*, although the exact characters and extent of this subgroup can

scarcely be established at present. Whatever these characters may be, the genus *Dracunculus* is so distinct from the other forms that it may well be taken as representative of a special subfamily.

KEY TO TWO SUBFAMILIES OF FILARIIDÆ.

Vulva usually anterior, near mouth; spicules usually quite dissimilar. *Filariinæ* (p. 40)
 Vulva absent in gravid stage, the female genital organs discharging through the mouth; male unknown *Dracunculiniæ* (p. 39)

Subfamily DRACUNCULINÆ, new subfamily.

This subfamily is erected for the Guinea worm, *Dracunculus medinensis*, frequently called *Filaria medinensis*. The absence of a vulva in the adult stage is such a major character that this alone suffices to separate the worm from the true *Filaria*.

The generic and specific synonymy are as follows:

Genus DRACUNCULUS Knipphoff, 1759.

- 1689: *Dracunculus* Cuneilius, 1689a, 395-428; Pre-Linnaean.
 1712: *Dracunculus* Kæmpfer, 1712, 524-531; Pre-Linnaean.
 1759: *Dracunculus* Knipphoff (1759), 12 (monotypical, *medinensis*) [not *Dracunculus* Wiegman, 1834, reptile; not *Dracunculus* fish, see Kroyer, 1838-40a, 422, syn. of *Callionymus lyra*].—Diesing, 1861a, 695-698 (includes *persarum* [= *medinensis*], *oculi*, *æthiopicus*).—Gallandat, 1773a, 103-116 (m. *medinensis*).
 1773: *Vena* Gallandat, 1773a, 103-116 (m. *medinensis*).
 1792: *Nervus* Laporte, 1792b, 531 (m. *medinensis*).
 1896: *Dracuncius* Moniez, 1896, 317, misprint.
 1896: *Drakunkulus* Schneidemuëhl, 1896, 306, for *Dracunculus*.
 1905: *Dracuncul* Penel, 1905, 67, misprint.

The type of this genus is the Guinea worm, also known as the Medina worm. Nearly all articles, both in medical and in zoological literature, which refer to *Dracunculus* deal with this parasite.

The Medina Worm—DRACUNCULUS MEDINENSIS Linnaeus, 1758 Gallandat, 1773

- 1674: *Dracunculus veterum* Velsch (1674); Pre-Linnaean.
 1674: *Vena medinensis* Velsch (1674); Pre-Linnaean.
 1689: *Dracunculus* Cuneilius, 1689a, 395-428, and of most authors; Pre-Linnaean.
 1694: *Dracunculus persarum* Kæmpfer, 1694a; 1712, 524-535; Pre-Linnaean.
 1740: *Vena medina* Grunler, 1740a, 329-330; Pre-Linnaean.
 1758: *Gordius medinensis* Linnaeus, 1758a, 647 (includes *Vena medinensis* and *Dracunculus persarum*); in *Homo*; India.
 1760: *Dracunculus veterum* Pallas, 1760.
 1773: *Vena medinensis* (Linnaeus, 1758) Gallandat, 1773a, 103-116 [not of Larrey, 1812 (teste Blanchard, 1899e, 506)].
 1773: *Dracunculus medinensis* (Linnaeus, 1758) Gallandat, 1773a, 103-116.
 1777: *Dracunculus graecorum* Gruner, 1777a, 257-264.
 1781: *Dracunculus persarum* Fuchs, 1781a, 40 pp.
 1790: *Filaria medinensis* (Linnaeus, 1758) Gmelin, 1790a, 3039.
 1795: *Faria medinensis* (Linnaeus, 1758) Modeer, 1795, 143-167.

- 1819: *Filaria dracunculus* Bremser, 1819a, 194-221, pl. 4, fig. 1; *medinensis* renamed.
 1838: *Filaria medeninsis* Alessandrini, 1838, 2; misprint.
 1856: *Filaria aethiopica* Valenciennes, (1856), 259-261.
 1861: *Dracunculus aethiopicus* (Valenciennes, 1856) Diesing 1861a, 698.
 1863: *Dracunculus perlorum* Meissner, 1863, 51; misprint for *persarum*.
 1893: *Filaria guinensis* Duglison, 1893a, 440.
 1896: *Dracunculus medinensis* (Linnæus, 1758) Moniez, 1896, 317; misprint.
 1896: *Filaria* (*Dracunculus*) *medinensis* (Linnæus, 1758) Shipley, 1896, 147, 157, 163.
 1896: *Filaria aethiopica* Schneidemuehl, 1896, 306; for *aethiopica*.
 1896: *Dracunculus persarum* (Fuchs, 1781) Schneidemuehl, 1896, 306.
 Vernacular names: Guinea worm, Medina worm, Beenwurm, Brackwasserwurm, Tankwurm, Nestlewurm (in part only), *Filaria de Médine*, *Filaria de Medina*, vers de Guinée, Dragonneau (in part; compare *Gordius*).

Subfamily FILARIINÆ, new subfamily.

The subfamily which contains *Filaria* must be named *Filariinæ*. Its full characters are not established at present, but one of its chief characters must be the presence of a vulva in the adult female.

Genus FILARIA Mueller, 1787.

The type of this genus must be carefully restudied before a satisfactory generic diagnosis (see p. 34) is written. For the present we may divide it into three subgenera, to contain the filariæ reported for man, but it is quite probable that these subgenera will later be given generic rank. *Thelazia* also comes into consideration as a possible subgenus of *Filaria*. For a list of the species of *Filaria* which have been taken as types of distinct genera see p. 37.

For the purposes of this paper the remaining species of "*Filaria*" reported for man will be arranged as follows:

- A. Subgenus *Hamularia* Treutler, 1793.
- B. Subgenus *Loa* Stiles, 1905.
- C. Subgenus *Filaria* Mueller, 1787.
- D. Subgenus uncertain.
 - (a) Unstriated.
 - (b) Striated.
 - (c) Not stated.
 - (d) Not satisfactorily established as occurring in man.
- E. Collective group "*Microfilaria*."
- F. Species eliminated from subgenus *Filaria* and probably from genus *Filaria*.
- G. Collective group *Agamofilaria*.
- H. Genus *Filocapsularia*.
- I. Species probably to be eliminated both from *Filaria* and *Filariidæ*.
- J. Species definitely eliminated from genus *Filaria* and also from family *Filariidæ*.

A. Subgenus HAMULARIA Treutler, 1793.

1793: *Hamularia* Treutler, 1793, 10-13 (m. *lymphatica*=*equina*).

1800: *Tentacularia* Zeder, 1800a, 5; *Hamularia* renamed. [Not *Tentacularia* Bosc, 1797.]

1840: *Haularia* Lee, 1840a, 282; misprint.

Hamularia lymphatica has recently been identified with *Filaria equina*. The mouth, tail, and certain other characters of this worm differ so radically from *Filaria martis* that *equina* can scarcely be placed in the typical subgenus *Filaria*. It may at present be admitted to only subgeneric rank (for the sake of conservatism), but with the statement that it will probably soon be raised to generic rank. For this group the generic name *Hamularia* is at present available.

In this connection it should be stated that for years authors were not in accord as to the zoological position of *Hamularia*. Some authors have thought that the type *Hamularia lymphatica* is identical with *Strongylus longicraginatus* (= *Metastrongylus apri*). Leuckart first thought it was an *Ascaris mystax* (= *Torocara*), but nearly all recent authors consider it a *Filaria*, while Linstow (1902, 222) and Braun (1903, 276) have accepted it as identical with *Filaria equina*. On authority of this latter interpretation, *Hamularia* may be considered as an available name for the subgenus in which *Filaria equina* is placed, unless it be shown that Linstow and Braun are in error in their conclusion. On their authority I accept their synonymy, and this acceptance makes it obligatory on me to use *Hamularia* in this place. The synonymy of the species in question is as follows:

FILARIA EQUINA (Abildgaard, 1789) Blanchard, 1849.

1781 or 1789: *Gordius equinus* Abildgaard (1781), v. 3, 49, pl. 109, fig. 12; (1789), 49; 1790, 28.

1790: *Filaria equi* Gmelin, 1790a, 3039.

1793: *Hamularia lymphatica* Treutler, 1793, 10-13, pl. 2, figs. 3-7; in *Homo*, Europe.

1802: *Filaria papillosa* Rudolphi, 1802a, 2-3.

1803: *Tentacularia subcompressa* Zeder, 1803a, 45; *Hamularia lymphatica*, 1793, renamed.

1809: *Hamularia subcompressa* (Zeder, 1803) Rudolphi, 1809a, 82-83.

1810: *Amularia linfatica* Brera, 1810a, 225-231; 1810b, pl. 4, figs. 1-3; for *Hamularia lymphatica* 1793.

1819: *Filaria bronchialis* Rudolphi, 1819a, 7 (syn. of *F. hominis bronchialis*) [not *F. bronchialis* (= *Metastrongylus*) of Veterinarian, 1857, of calves].

1819: *Filaria hominis bronchialis* Rudolphi, 1819a, 7, 215-216; *Hamularia lymphatica* 1793, renamed.

1823: ? *Ascaris pellucidus* Kennedy, 1823a, 107-111; in eye of horse; India.

1840: *Haularia subcompressa* (Zeder, 1803) Lee, 1840a, 282; misprint.

1840: *Filaire equi* (Gmelin, 1790) Lee, 1840a, 283; misprint.

1849: *Filaria equina* (Abildgaard, 1789) Blanchard, 1849a, 154-155, pl. 6, fig. 3.

1851: *Filaria hominis* Diesing, 1851a, 279, 535, 567; *Hamularia lymphatica* 1793, renamed [not *F. hominis* for *F. sanguinis hominis*].

- 1859: *Filaria bronchialis hominis* Gervais & van Beneden, 1859b, 145; *Hamularia lymphatica* 1793, renamed.
 1860: *Filaria lymphatica* (Treutler, 1793) Moquin-Tandon, 1860a, 337.
 1860: *Trichosoma subcompressa* (Zeder, 1803) Moquin-Tandon, 1860a, 337, apparently lapsus.
 1876: ?*Filaria sanguinis equi* Sonsino, (1876).
 1876: *Filaria bronchialis hominis* de Bonis, 1876a, 130, pl. 2, fig. 2.
 1879: *Strongylus* (*Filaria*) *bronchialis* (Rudolphi, 1819) Cobbold, 1879b, 207-208.
 1894: *Filaria equie* Francis, 1894a, 451; misprint for *equina*.
 1894: ?*Filaria pellucida* (Kennedy, 1823) Dolley, 1894a, 994 (as young of *F. equina*).
 1896: *Filaria hamulosa* Schneidemuehl, 1896, 308.

B. Subgenus LOA Stiles, 1905.

- 1905: *Loa* Stiles in Stiles & Hassall, 1905, Dec., 150 (m. *loa*; in man, Africa).

The species *Filaria loa* differs so from the other filariae of man, in the presence of bosses on the skin and in the form of the caudal papillae that it may well be taken as the type of a special subgenus. This group also will probably eventually prove to be of generic value, as Cobbold has already suggested.

The loa—FILARIA LOA (Cobbold, 1864).

- 1812: *Vena medinensis* of Larrey, 1812 (teste Blanchard, 1899e, 506) [not of Gallandat, 1773a].
 1845: *Filaria lacrymalis* Dujardin, 1845a, 46 [not Gurlt, 1831a]; Dubini, 1850b, Mar. 4, 576; 1850b, Apr. 20, 21-22; in *Homo*; not *F. lacrymalis* Gurlt, 1831, in horse.
 1850: *Filaria lacrymalis* Dubini, 1850b, Mar. 4, 577; for *lacrymalis*.
 1859: *Filaria oculi* Gervais & Beneden, 1859b, 142-144; [not *F. oculi* Siebold, 1839, 158, based on Ammon, 1838, figs. 22, 23; not *F. oculi* Clarkson, 1845a, of horses; not *F. oculi* of parrots].
 1860: *Dracunculus oculi* (Gervais & Beneden, 1859) Diesing, 1861a, 697. [Possibly this combination was used by Cobbold at an earlier date.]
 1864: *Dracunculus loa* Cobbold, 1864b, 147, 388-389 [the name was probably used by Cobbold in some earlier publication].
 1865: *Filaria subconjunctivalis* Guyon, 1865a, 58-59.
 1866: *Filaria loa* (Cobbold, 1864) Aitken, 1866, 881.
 1878: *Filaria loa* Zool. Rec., v. 13 (1876) 1878, Verm., 17; misprint.
 1891: *Filaria sanguinis hominis major* Manson, 1891, Jan. 3, 4; sheathed diurnal larva in blood.
 1891: *Filaria diurna* Manson, 1891, Aug. 26, 203 (larval form in blood of *Homo* in Africa).
 1891: *Filaria sanguinis hominis diurna* Manson, 1891, Aug. 26, 202.
 1900: *Filaria sanguinis diurna* Linstow, 1900, 76.
 1901: *Filaria loa* Vaullegeard, 1901, 128; misprint for *loa*.
 1904: *Filaria bourgii* Brumpt, 1904, — (larval form in blood).
 1905: *Draconculus oculi* (Gervais & Beneden, 1859) Penel, 1905, 67; misprint.
 1905: *Draconculus loa* (Cobbold, 1864) Penel, 1905, 67; misprint.
 1905: *Filaria conjunctivalis* Penel, 1905, 67; misprint.
 1905: *Filaria bourgi* Penel, 1905, 75, 82; for *bourgii*.
 1906: *Microfilaria diurna* (Manson, 1891) Shipley & Fearnside, 1906, 18.

C. Subgenus *FILARIA* Mueller, 1787.

For synonymy see p. 36.

Some species of *Filaria* are described as possessing a transverse striation, others as without such striation. A difference of this kind, if constant in the species in question, would probably represent at least a subgeneric, possibly a generic character—that is, assuming the striation to be distinct, as we find it in certain other groups of *Nematoda*. The exact nature of the striation reported for some of the *Filariidae* may well be restudied, however, for it does not seem to be excluded that at least in some cases a pseudostriation may perhaps have been erroneously interpreted as a true striation. According to Alessandrini, *Filaria martis* (the generic type) is not transversely striated. Until this species is restudied it can not be positively stated which other species of *Filaria* should be placed in the typical subgenus, and while it is possible that some of the forms which are found in man may belong here, this point may well be left open until the generic type is better understood.

D. Subgenus uncertain.

Until *Filaria martis* is restudied, in order to determine the characters of the typical subgenus, the exact systematic subgeneric position of the following parasites of man (and also of nearly all the other species of *Filaria* reported for different animals) remains *sub judice*.

(a) Species reported as not possessing a transverse striation on the cuticle:

Bancroft's *Filaria*—*FILARIA BANCROFTI* Cobbold, 1877.

- 1872: *Filaria sanguinis hominis* Lancet, London, 1872, Aug. 31, 310; based on Lewis's work; Busk responsible for generic determination; larval form, in blood of *Homo*; Calcutta.—Manson, 1891, Jan. 3, 4, restricted to nocturnal sheathed larva in blood.
- 1874: *Filaria sanguinis hominis aegyptiaca* Sonsino, (1874).
- 1875: *Filariose dermatemica* Silva Araujo, 1875; da Silva Lima, 1877, Sept., 389; apparently as name of disease; for *craw-craw* in Bahia—Cobbold, 1878b, 362, 365, apparently as name of parasite, in synonymy of *F. bancrofti*.
- 1875: *Filaria dermatemica* Silva Araujo, 1875, 39–86; in *Homo*, Brazil.
- 1877: *Filaria bancrofti* Cobbold, 1877g, July 14, 70–71; adult, in *Homo*, Queensland, Australia.
- 1877: *Filaria wuchereri* Silva Lima, 1877, Sept., 395.
- 1877: *Wuchereria filaria* Silva Araujo, 1877, Nov., 492–504; possibly lapsus for *Filaria wuchereria*, or possibly as new name.
- 1877: *Filaria wuchereria* Felicio dos Santos, 1877, Mar., 137; 1877, Dec., 539; same as *F. wuchereri*; in elephantiasis of scrotum; Rio de Janeiro.
- 1877: *Filaria wuchercira* Magalhães in Silva Lima, 1877, Dec., 544.
- 1877: *Filaria sanguinis hominis* Magalhães, in Silva Lima, 1877, Dec., 544; misprint.
- 1878: *Filaria sanguinis* Beneden, 1878a, 276; of man; not *F. sanguinis* of dogs, of frogs, and of other animals.

- 1878: *Filaria sanguinolenta* Brit. M. J., teste Cobbold, 1878c, 366; of man, not of dogs.
 1878: *Filaria sanguinis hominis egyptiaca* Bourel-Roncière, 1878a, 122; for *F. s. h. egyptiaca*.
 1879: *Filaria wucherii* Fayrer, 1879b, 189; for *wuchereri*.
 1879: *Filaria dermitemica* Fayrer, 1879b, 189; misprint.
 1879: *Filaria bancroftii* Fayrer, 1879b, 189; for *bancrofti*.
 1883: *Filaria bancrofti* Braun, 1883a, 183; for *bancrofti*.
 1883: *Filaria egyptiaca* (Sonsino, 1874) Braun, 1883a, 183.
 1883: *Filaria sanguinis humani* La Clinica de Malaga, 1883, 309.
 1884: *Filaria sanguinis hominis* (Lancet, 1877) Calmette, 1884a, 456; misprint.
 1885: *Filaria sanguinis hominum* Hall, 1885a, 40, for *F. s. hominis*.
 1889: *Filaria hominis*—Author?—, 1889, for *F. sanguinis hominis*.
 1889: *Filaria sanguis hominis* Gwynn, 1889a, 43–47; for *F. sanguinis hominis*.
 1891: *Filaria nocturna* Manson, 1891, Aug. 26, 204; larva in blood.
 1891: *Filaria sanguinis hominis nocturna* Manson, 1891, Aug. 26, 204.
 1892: *Filaria sanguinis* Manson, 1892, 79; for *F. sanguinis hominis*.
 1893: *Filaria cystica* (Salisbury, 1868) Railliet, 1893a, 515, in part only; not *F. cystica* Rudolphi, 1819a.
 1896: *Trichina sanguinis hominis nocturna* (Manson, 1891) Huber, 1896a, 604; lapsus for *Filaria s. h. n.*
 1896: *Filaria mansonii* Huber, 1896a, 604; not *F. mansonii* Cobbold, 1879b, of chickens.
 1896: *Filaria sanguinis hominis nocturnæ* Henry, 1896g, 669, for *F. s. h. nocturna*.
 1901: *Filaria sanguinis nocturna* Vickery, 1901, June 15, 206, for *F. s. h. nocturna*.
 1903: *Filaria sanguinis hominis nocturnis* Johnstone, 1903a, 34–42, for *F. s. h. nocturna*.
 1905: *Filaria dermatemica* Penel, 1905, 11, 13; for *dermatemica*.
 1906: *Microfilaria nocturna* (Manson, 1891) Shipley & Fearnside, 1906, 17.
 ?——: *Filaria sanguinis hominis bancrofti*.
 Vernacular names: Vers de la Guadeloupe, Vers de Bresil, the hæmatozoon, Lewis's filaria, Chinese filaria, Wucherer's filaria.

In the foregoing synonymy I have included the names which are usually supposed to apply to the species in question. It may be pointed out, however, that the possibility is not entirely excluded that some of the names really apply to distinct subspecies, or possibly to distinct species. Is, for instance, the true *F. bancrofti* (type locality Australia) really identical with the Egyptian and the Brazilian worms which are usually classified in this species? This point needs further study.

In connection with the forms in question the names *Filariose*, *Wuchereria*, and *Microfilaria* (see p. 46) come up for consideration in case *F. bancrofti* eventually proves to be generically or subgenerically distinct from *F. martis*. As I interpret these names, *Filariose* was originally used as technical term for the disease, and it was later misquoted as a generic name. I rather doubt whether this would be available as generic name from the date of its misquotation. *Wuchereria* might be interpreted as a true generic name, although the possibility is not excluded that it was only used accidentally as such. *Microfilaria* seems to have been proposed distinctly as a collective name for the embryonic or larval stage and does not, I believe, have any right to priority as a true generic name. There is, however, some legitimate room for a difference of opinion on these points.

FILARIA PERSTANS Manson, 1891.

- 1891: *Filaria sanguinis hominis minor* Manson, 1891, Jan. 3, 4; larva in blood of *Homo*; no sheath, no periodicity. Quadrinomial used for a "distinct species," hence it has no nomenclatural status and does not therefore take precedence over *Filaria perstans*.
- 1891: *Filaria perstans* Manson, 1891, Aug. 26, 203; larva in blood of *Homo* from Africa.
- 1891: *Filaria sanguinis hominis perstans* Manson, 1891, Aug. 26, 202; 1892, 79.
- 1892: *Filaria perstans* Manson, 1892, 85; misprint.
- 1902: *Filaria sanguinis perstans* Fagge & Pye Smith, 1902, 474.

(b) Species which are reported as possessing transverse striations on the cuticle:

? FILARIA BANCROFTI.

See p. 43. Some authors report transverse striations for this species.

FILARIA CONJUNCTIVÆ Addario, 1885.

- 1823: ?*Ascaris pellucidus*. See also p. 41.
- 1867: ?*Filaria palpebralis* Pace (1867), in *Homo*; not Wilson, 1844, of horses.
- 1879: *Filaria peritonei hominis* Babès, 1879a, 554; in *Homo*; Budapest.
- 1880: *Filaria peritonei hominis* Babès, 1880a, 158-165, for *F. peritonei hominis*.
- 1885: *Filaria conjunctivæ* Addario, 1885, 135-148, figs. 1-8; in *Homo*; Catania, Italy.
- 1887: *Filaria inermis* Grassi, 1887g, 617-623, figs. 1-3; *F. conjunctivæ* 1883, renamed.
- 1892: *Filaria apapillocephala* Condorelli-Francaviglia, 1892e, 168-179.
- 1894: ?*Filaria pellucida*. See also p. 42.
- 1899: *Filaria conjunctivæ* Assenova, 1899, 50, 110, 103; misprint.
- 1905: *Filaria conjunctivæ* Penel, 1905, 8; misprint.

Magalhães's Filaria—FILARIA MAGALHÃESI Blanchard, 1895.

- 1887: "*Filaria bancrofti*" of Magalhães, 1887, 126-219, misdetermined: heart of *Homo*; Rio de Janeiro, Brazil.
- 1892: *Filaria sanguinis hominis* of Magalhães, 1892, 7. Oct., 513, fig. 2, not *F. s. h.* of *F. bancrofti*.
- 1895: *Filaria magalhãesi* Blanchard, 1895, 771, 782-783, based on Magalhães, 1887, 126-219.
- 1897: *Filaria megalhaesi* Manson, 1897, Dec. 25, 1837; misprint.
- 1898: *Filaria magalhaes* Daniels, 1898a, 1012; misprint.
- 1901: *Filaria magalhãesi* Annett, Dutton & Elliott, 1901, Sept., pt. 2, 43, 47, 49.
- 1901: *Filaria megalhãsi* Manson, 1901, 562; misprint.
- 1903: *Filaria magalhãesi* Manson, 1903, 3 ed., 546, 604.
- 1903: *Filaria megalhaes* Daniels, 1903, 121; misprint.
- 1905: *Filaria magalhãesi* Penel, 1905, 113; misprint.

FILARIA VOLVULUS Leuckart, 1892.

- 1892: *Filaria volvulus* Leuckart, in Manson, 1892, 88; evidently misprint for *volvulus*.
- 1893: *Filaria volvulus* Leuckart, in Manson, 1893, 963; evidently a typographical error for *F. volvulus*.
- 1893: *Filaria volvulus* Leuckart, in Manson, 1893, 963, corrected form of *F. volvulus*; in *Homo*; Gold Coast, Africa.

(c) Transverse striation neither affirmed or denied:

Demarquay's *Filaria*—**FILARIA DEMARQUAYI** Manson, 1897.

- 1897: *Filaria demarquayi* Manson, 1897, Dec. 25, 1837–1838; in *Homo*; St. Vincent.
 1897: *Filaria ozzardi* Manson, 1897, Dec. 25, 1838 (in part, namely, sharp tailed form).—Blanchard, 1905a, 537.
 1899: *Filaria demarquayii* Galgey, 1899a, 145–146; for *demarquayi*.
 1905: *Filaria demarquagi* Penel, 1905, 92; misprint.
 1905: *Filaria demarquii* Linstow in Low, 1905d, 39.

Ozzard's *Filaria*—**FILARIA OZZARDI** Manson, 1897.

- 1897: *Filaria ozzardi* Manson, 1897, Dec. 25, 1838, figs. 5–6; in *Homo*; British Guiana.
 1902: *Filaria ozzardii* Daniels, 1902, Dec. 1, 358; for *ozzardi*.

(d) Not satisfactorily established as occurring in man:

The cruel filaria—**FILARIA IMMITIS** Leidy, 1856.

- 1850: *Filaria canis cordis* Leidy, 1850f, 118 (in heart of *Canis familiaris*; U. S. A.); 1856a, 2; 1856b, 55; 1880b; 1904a, 40, 101, 157.
 1852: *Filaria papillosa hæmatica canis domestici* Gruby & Delafond (1852).
 1856: *Filaria immitis* Leidy, 1856b, 55; 1880b; 1904a, 101, 157; *F. canis cordis* named binominally.
 1866: *Filaria papillosa hæmatica* Schneider, 1866a, 87.
 1875: *Filaria hæmatica* Ercolani, 1875e, 38.—Galeb & Pourquier, 1877a, 271–273 (congenital case in dog); 1877b, 95; 1877c, 127–129; 1877f, 352.
 1875: *Spiroptera immitis* (Leidy, 1856) Ercolani, 1875e, 38.
 1877: *Filaria ematica* Galeb & Pourquier, 1877d, 140–141 (for *F. hæmatica*).
 1879: *Filaria iminitis* Fayerer, 1879b, 222; misprint.
 1886: *Filaria sanguinis immitis* Vet. J., 1886, 230.
 1896: *Filaria papillosa hæmatika* Schneidemuehl; 1896, 307.
 1897: *Filaria papillosa ematica* Giuseppi, 1897a, 185.
 1902: *Filaria immitis* Daniels, 1902, 47; misprint.
 1904: *Filaria immilis* Leidy, 1904a, 157; misprint.
 —: *Filaria canina*.

E. Collective group “**MICROFILARIA**.”—Larval filaria in the blood.

The following species of “*Filaria*” have been based upon larval forms found in the blood of man. It is impossible to place them subgenerically until the adult stage is studied. The name *Microfilaria* appears to me to have the status of a collective group rather than a generic status. It refers to microscopic larval or embryonic filariae found in the blood.

FILARIA PHILIPPINENSIS Ashburn & Craig, 1906.

- 1906: *Filaria philippinensis* Ashburn & Craig, 1906, Sept., 435–443, figs. 1–5, in blood of *Homo*, at Manila, P. I., day and night, sheath present; 1906, Sept. 8, 514.

FILARIA POWELLI Penel, 1905, species dubia.

- 1905: *Filaria powelli* Penel, 1905, 126, based on Powell, 1903, May 16, 1145 (*Homo*; Bombay, India).—Blanchard, 1905a, 538.
 1905: *Filaria povelli* Penel, 1905, 10, for *F. powelli*.

FILARIA sp. Cholodkowsky, 1896.

1896: *Filaria* sp. Cholodkowsky, 1906, 59; 1907, 185.—Braun, 1903, 3 ed., 278; in *Homo*; Tver.

FILARIA sp. O'Neill, 1875.

1875: *Filaria* sp. O'Neill, 1875, Feb. 20, 265-266, fig. 1 (in *Homo*, cases of craw-craw; West Coast of Africa); 1875, 229; 1898, 204.—Braun, 1883a, 182.—Cobbold, 1878h, 370.

FILARIA sp. Prout, 1902.

1902: *Filaria* sp. Prout, 1902, Sept. 20, 880; in blood of *Homo*, in Freetown, Sierra Leone, West Africa; 1902, Oct. 15, 318.

F. Species to be eliminated from **FILARIA** (**FILARIA**).

The following species should doubtless be eliminated from *Filaria* (*Filaria*), but their exact generic and subfamily position is *sub judice*:

(FILARIA?) LABIALIS Pane, 1864.

1864: *Filaria labialis*, Pane, (1864), 32-34 (in *Homo*; Naples, Italy).—Addario, 1885, 143.—Anders, 1903, 1258.—Annett, Dutton & Elliott, 1901, 1. 4.—Assenova, 1899, 50, 52-53, 102, 120.—Beneden, 1878a, 278.—Blanchard, 1890a, 14-15, fig. 391; 1895, 785.—de Bonis, 1882, 123.—Braun, 1883a, 182; 1895, 227; 1903, 3ed., 275-276.—Cobbold, 1879b, 207.—Davaïne, 1877a, cvii.—Dunglison, 1893a, 440.—Huber, 1896, 501.—Ijima, 1889b, 345.—Leuckart, 1876, 616-618, fig. 307.—Moniez, 1896, 359-360.—Mosler & Peiper, 1894, 218-219.—Packard, 518.—Penel, 1905, 8.—Stoss, 1897, 31.—Tyson, 1903, 1197.—Vaullegeard, 1901, 124.—Vogt, 1878, 11, 13.—Ward, 1895, 331; 1903, 212; 1903, 704.—Wood & Fitz, 1897, 342.

The position of the vulva, if correctly interpreted, excludes this worm from the genus *Filaria*.

(FILARIA?) KILIMARÆ Kolb, 1898.

1898: *Filaria kilimare* Kolb, 1898a, Feb., 28-33 (in *Homo*, etc.; Kilimara, British East Africa); 1898b, 633-634; 1898c, 300.—Braun, 1903, 3. ed., 277-278.—Looss, 1905, 180.—Penel, 1905, 8.—Ward, 1903, 704.

(FILARIA?) ROMANORUM ORIENTALIS Sarcini, 1888.

1888: *Filaria romanorum orientalis* Sarcini, 1888, Feb. 12, 2-4 (in blood of *Homo sapiens*; Roumania).—Blanchard, 1895b, 168-169 (nature very problematic); 1895, 786.—Braun, 1903, 3. ed., 277.—Ward, 1903, 215; 1903, 704.

G. Collective group **AGAMOFILARIA** Stiles, 1907.

As stated on p. 10 I propose to use the term *Agamofilaria* as name of a collective group, in which may be placed the agamic or immature filarial worms which can not at present be more definitely classified. The following forms come into consideration in connection with the parasites of man.

AGAMOFILARIA GEORGIANA Stiles, 1907.

See p. 11 of this bulletin.

(AGAMOFILARIA?) OCULI (Siebold, 1839) Stiles, 1907, species dubia.

- 1832: *Filaria oculi humani* Nordmann, 1832, 7-8; in *Homo*; Berlin, Germany; 1843, 67.
 1839: *Filaria oculi* Siebold, 1839, 158, based on Ammon, 1838, figs. 22, 23, in *Homo*;
 not *F. oculi* Clarkson, 1845a, of horses; not *F. oculi* of parrots; not *F. oculi*
 Gervais & Beneden, 1859, see *F. loa*.
 1851: *Filaria lentis* Diesing, 1851a, 265; binominal for *F. oculi humani*.
 1880: *Filaria oculis* Chiralt, 1880a, 2-9, 1 fig.; 1882a, 473-480.
 1896: *Filaria okuli humani* Schneidemuëhl, 1896, 304.
 1901: *Filaria oculi hominis* Vaullegeard, 1901, 129.

Diesing's (1851) specific name *lentis* is usually adopted for this species, but so far as I can find, *oculi*, 1839, is the first available name.

H. Genus FILOCAPSULARIA Deslongchamps, 1824.

- 1824: *Filocapsularia* Deslongchamps, 1824q, 398-400 (m. *communis* Deslongchamps, 1824q, 399-400, a species which includes a number of previously named species).

One alleged parasite of man (namely, *Spiroptera hominis*=*Filaria piscium*) should apparently be classified in this genus. The exact position of the genus is uncertain.

"SPIROPTERA HOMINIS" Rudolphi, 1819.

- 1809: *Filaria piscium* Rudolphi, 1809a, 74-75.—Meissner, 1863, 55.
 1819: *Spiroptera hominis* Rudolphi, 1819a, 27, 250-253 (in *Homo*, female: London).—
 Beneden, 1878a, 279 (syn. of *Filaria piscium*).—Gervais & van Beneden,
 1859a, 146-147.—Guës, 1879a, 181.—Meissner, 1863, 55 (syn. of *Filaria*
piscium).
 1824: *Filocapsularia communis* Deslongchamps, 1824q, 399-400; in fish.
 1825: *Spiroptera rudolphi* delle Chiaje, 1825, 7-8, pl. 1, fig. 3; *S. hominis* renamed.
 1825: *Spiroptera rudolphiana* delle Chiaje, 1825a 7, apparently intended as Italian
 for *S. rudolphi*, but accepted by some later authors (as Blanchard, 1889d,
 706) as a Latin name.
 1851: *Agamonema commune* (Deslongchamps, 1824) Diesing, 1851a, 120-121; in fish.
 1851: *Strongylus gigas pullus* Diesing, 1851a, 223 (refers to Bremser, 1819a, 226, pl. 4,
 figs. 6-10), as syn. of *Spiroptera hominis*.
 1851: *Spiroptera rudolphii* Diesing, 1851a, 223 (for *S. rudolphi*) as syn. of *Sp. hominis*.

This was a spurious parasite. It was afterwards shown to be *Filaria piscium*, a species which is classified as *Filocapsularia communis* or *Agamonema piscium*.

I. Species probably eliminated from FILARIA and FILARIIDÆ.

The following species can be probably eliminated, not only from the genus *Filaria*, but also from the family *Filaridæ*.

(FILARIA?) HOMINIS ORIS Leidy, 1850? = **MERMITHIDÆ**

1850: *Filaria hominis oris* Leidy, 1850f, 117; (in mouth of a child; U. S. A.); 1856b; 1904a, 40, 101 (as possible syn. of *F. medinensis*).—Anders, 1903, 6 ed., 1258.—Anderson, 1903, 1258.—Annett, Dutton, Elliott, 1901, 14.—Beneden, 1878a, 278.—Blanchard, 1890a, 13-14; 1895, 785.—Braun, 1883a, 182; 1895b, 227; 1903, 3 ed., 275.—Cobbold, 1879b, 207.—Dunglison, 1893a, 440.—Leuckart, 1876, 617.—Lewis, 1879, 257.—Moniez, 1896, 359.—Packard, —, 518.—Penel, 1895, 8.—Tyson, 1903, 3 ed., 1198.—Ward, 1895, 330; 1903, 704; 1903, 212.

SPECIFIC DIAGNOSIS.—*Filaria*?: "Body, white, opaque, linear, thread-like; mouth round, simple; posterior extremity obtuse, furnished with a short, curved, epidermal hooklet 1-500th in. in length by 1-2000th in. in diameter at base. Length, 5 inches 7 lines; greatest breadth, 1-66th in.; breadth at mouth, 1-250th in.; at posterior extremity 1-80th in."—Leidy, 1850f, p. 117.

HABITAT.—Obtained from mouth of a child.

MEDICAL SIGNIFICANCE.—At the present time this species is without any medical significance, and from the original description of the worm it is impossible to pass any positive judgment upon it from a zoological point of view. The question naturally arises, however, whether this worm was not in reality a hair worm (possibly *Mermis*), which accidentally gained access to the mouth, possibly through eating an apple. On several occasions worms which were found in apples have been sent to me; they were probably parasitic in some insect, which in turn was parasitic in an apple; they agree fairly well with Leidy's original short description of *Filaria hominis oris*, and possess the "epidermal hooklet" on the end of the tail. Such worms could easily gain access to the mouth through eating apples.

Leidy's description does not apply very well to the genus *Filaria*; furthermore, it would be rather strange to find a true *Filaria*, 5 inches long, in the mouth. While no positive opinion can be expressed unless Leidy's original specimen^b can be found, I incline to the view that *Filaria hominis oris* was probably a *Mermis*. Such a worm would probably be of very slight, if of any, medical importance.

(FILARIA?) GIGAS Prout, 1902, species dubia = ? Insect hairs.

1902: *Filaria gigas* Prout, 1902, Sept. 20, 880 (in *Homo*; Moyamba, Sierra Leone, West Africa); 1902, Oct. 15, 318-319; 1905, Sept. 16, 683.—Blanchard, 1905a, 538.—Looss, 1905c, 170 (possibly only a sheath).—Low, 1905b, 1329-1330 (probably insect hairs).—Manson, 1903, 546, 604.—Penel, 1905, 5, 10, 81, 125, 141, 147.

^aThis name is here retained although, being a specific trinomial, it has no status in nomenclature as a specific name. Since however the species is so doubtful, there is no object in giving to it another name. As here used, *Filaria hominis oris* simply represents the Latin for "a filaria in the mouth of man."

^bEdw. J. Nolan, secretary of the Academy of Sciences, Philadelphia, informs me that the original specimen can not be found in Philadelphia, and that it has probably been destroyed.

NEMATOIDEUM TRACHEALE Cobbold, 1864.

- 1855: *Entozoon found in the larynx* Rainey, 1855, 370-372, pl. 17, fig. 1.
 1864: *Filaria trachealis* Cobbold, 1864b, 333 (based on Rainey, 1855, 370; syn. *Nematoideum tracheale*, as possibly referable to *Ascaris megaloccephala* or *A. suilla*); 1866a, 7; 1867a, 6; 1883w, 513.—Anders, 1903, 6 ed., 1258.—Blanchard, 1888a, 740, 741, fig. 364; 1888r, 39 ("perhaps *Strongylus longevaginitus*"); 1895, 755 (syn. of *Strongylus apri*).—Dunglison, 1893a, 821; 1900a, 821 (or *bronchialis*).—Looss, 1905c, 154 (as possibly identical with *Strongylus paradoxus*).—Moniez, 1896, 389 (as possibly identical with *Strongylus paradoxus*).—Packard, —, 518.—Verrill, 1870, 171.—Ward, 1903, 219 (as possibly identical with *Strongylus apri*).
 1864: *Nematoideum tracheale* Rainey & Bristowe, feste Cobbold, 1864b, 333 (as syn. of "? *Filaria trachealis*"); 1866a, 6; 1867a, 6. [I can not find where Rainey & Bristowe used this name.]
 1879: *Filaria (Nematoideum) trachealis* of Cobbold, 1879b, 207.

J. Species to be eliminated from *FILARIIDÆ*.

The following species can be definitely eliminated from the family *Filariidæ*:

AGAMOMERMIS RESTIFORMIS (Leidy, 1880) Stiles, 1907.

- 1880: *Filaria restiformis*, Leidy, 1880c, June 1, 130-132, figs. 1-2 (in *Homo*; West Virginia); 1904a, 157-159, 278.—Blanchard, 1890a, 13, fig. 390a-b; 1895, 785.—Braun, 1883a, 184; 1895b, 227; 1903, 3. ed., 275.—Ijima, 1889b, 367.—Moniez, 1896, 359.—Penel, 1905, 8.—Stossich, 1897, 78.—Vaullegeard, 1901, 128.—Ward, 1895, 331; 1903, 704; 1903, 212.

In a later paper I will show that this species, of which I have found the type specimen, belongs to the *Mermithidæ*.

"FILARIA CYSTICA" (Salisbury, 1868) = OXYURIS VERMICULARIS.

- 1868: *Trichina cystica* Salisbury, 1868, April, 376-377, figs. 29-31; in bladder of *Homo* (female); Cleveland, Ohio, U. S. A.—Blanchard, 1897e, 167 (syn. of *Filaria sanguinis hominis*).—Bourel-Roncière, 1878a, 116; 1888a, 131.—Cobbold, 1880e, 58.—Cunningham, 1873a, 835-836, fig. 2 (there is reason to suspect that this is *Oxyuris vermicularis*).—Fayrer, 1879b, 189.—Huber, 1896a, 604 (syn. of *Filaria sanguinis hominis*).—Leuckart, 1876a, 637.—Lewis, 1879c, 247-249, fig. 1 (does not believe it is *F. s. hominis*).—Penel, 1905, 2 ed., 11, 12.—Railliet, 1893a, 515 (syn. of *Filaria bancrofti*).—Ransom, 1904, 25.—da Silva Lima, 1877, Nov., 489.—Stiles, 1905, IV, 29, 682 (syn. of *Oxyuris vermicularis*).—Ward, 1895, 320, 321 (syn. of *Filaria bancrofti*); 1903, 213.
 1868: *Filaria cystica* (Salisbury, 1868) Cobbold, 1879b, 202.—Dolley, 1894a, 993 (syn. of *Filaria sanguinis hominis*); 1901, 993.—Linstow, 1900c, 76.—Moniez, 1896, 338.—Railliet, 1893a, 515.—Shipley, 1896, 142.—Stiles, 1905, IV, 29, 682.
 1879: *Filaria salisburyi* Cobbold, 1879b, 188; *Trichina cystica* 1868, renamed.
 1894: *Filaria salisburyi* Dolley, 1894a, 1901a, 994; for *salisburyi*.
 1896: *Trichina cystica* Schneidemuehl, 1896, 306; for *cystica*; as syn. of *Filaria sanguinis hominis*.

There can be scarcely any reasonable doubt regarding the identity of this form with the common pinworm, *Oxyuris (Oxyurias) vermicularis*, of man.

FILARIA NIELLYI (Blanchard, 1885) Moniez, 1889—**RHABDITIS NIELLYI**.

- 1882: "*Anguillula leptodera*?" Nielly, 1882, 16 April, 395-405; in *Homo*, near Brest; 1882, Mai, 337-345, figs. 1-3.
- 1885: *Leptodera niellyi* Blanchard (1885), — based on Nielly, 1882, 337-345, figs. 1-3. [Original publication not found.]
- 1888: *Rhabditis niellyi* (Blanchard 1885) Blanchard (1888). [Original publication not found.]
- 1889: *Filaria niellyi* (Blanchard 1885) Moniez, 1889, 192.

FILARIA ZEBRA Mongrand, 1852, species fictitia.

- 1852: *Filaria zebra* Mongrand 1852, Feb. 1, 63-64 (in vena saphena interna of a convict, *Homo*, at Brest).—Blanchard, 1889d, 706.—Moquin-Tandon, 1860, 388.

This spurious parasite, described by Mongrand, has been recognized by Davaine & Robin as a fibrinous clot.

THREE NEW AMERICAN CASES OF INFECTION OF MAN WITH HORSE-HAIR WORMS (SPECIES PARAGORDIUS VARIUS), WITH SUMMARY OF ALL CASES REPORTED TO DATE.

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(Figs. 35-55.)

There is a popular belief, extending back for centuries, that horse-hair worms (*Gordiiidae*), if swallowed by man or animals, will cause very serious, even fatal, disease; but the actual cases of such infections thus far definitely recorded in medical and zoological literature are but few in number; and medical men who have reported cases do not share the belief of the laity relative to the supposed dangerous character of these worms.

In recent years I have had specimens from two such cases referred to me for identification, and have seen another specimen from an unpublished case, and this has led me to consult the original references of all reported cases, so far as the literature is accessible to me.

The worms in question belong to the *Gordiaceae*, a group of worms classified by some authors as a family of nematodes, by others as a distinct order of the *Nemathelminthes*. Their general relations to the other round worms may be seen from the following key:

KEY TO THE ORDERS OF NEMATHELMINTHES.

[For forms known to occur in man in the United States, follow roman type.]

1. Anterior end provided with a proboscis, armed with several rows of thorns or hooks; intestine absent; adults parasitic in intestine; very rare in man; thorn-headed worms *Acanthocephala*
Anterior end not provided with a thorny proboscis; intestine present, complete or in part rudimentary 2
2. Intestinal canal of adult usually complete, but in some cases (*Mesostoidia*) represented by esophagus and rudimentary intestine; papillae on head; spicules usually present in male; one testicle present in male; vulva always independent of anus except in *Cloacina*; most round worm parasites of man belong here *Nemathelminthes*
Intestinal canal always atrophied anteriorly in adult; head without papillae; spicules never present in male; two testicles present in male; vulva always united with posterior portion of intestine to form a cloaca; rare in man and then only as accidental parasites; horse-hair worms *Gordiaceae*

The technical name *Gordianea* is based upon the name of the type genus *Gordius*, and this in turn is taken from the fact that the worms have a habit, when in water, of entangling themselves, several together, into an inextricable mass, thus recalling the "Gordian knot."

The popular name "horse-hair worm" is taken from the popular, though of course erroneous, idea that these worms develop from horse hairs. In reality, the larval stages are parasitic, chiefly in insects, while normally the adults are free living.

It occasionally occurs that these worms are vomited by man or that they are passed in the stools. Authors are not agreed as to the method of infection. Some writers are of the opinion that the larval worm is swallowed and then develops further in man, while other writers hold that the adults are accidentally swallowed while a person is drinking at a fountain or brook.

The following is a tabular statement of 15 cases which I have been able to find recorded, together with three new cases:

From this table we may classify the 18 cases as follows:

BY SPECIES OF PARASITE: *Gordius aquaticus*, 4 cases; *Paragordius varius*, 4 cases; *P. tricuspidatus*, 1 case; *P. cinctus*, 1 case; *Parachordodes tolosanus*, 3 cases; *P. pustulosus*, 1 case; *P. violaceus*, 1 case; *P. alpestris*, 1 case; not stated, 2 cases.

BY COUNTRIES: Europe—Austria, 1 case; France, 5 cases; Germany, 1 case; Italy, 4 cases. North America—6 cases (1 each for Canada, Illinois, Ohio, Maine, Maryland, and Michigan). Africa—Transvaal, 1 case.

BY SEX OF PATIENT: Male, 9 cases; female, 4 cases; not stated, 5 cases.

BY AGE OF PATIENT: 0 to 10 years, 3 cases; 11 to 20 years, 2 cases; 21 to 30 years, 1 case; 31 to 40 years, 2 cases; 41 to 50 years, 2 cases; not stated, 8 cases (2 of which were apparently adults). Or—0 to 20 years, 5 cases; 21 to 40 years, 3 cases; 41 to 60 years, 2 cases; not stated, 8 cases. Kirtland's case ("a girl") can probably be counted under 21 years, thus giving 6 cases from 0–20.

THE PARASITES ESCAPED: By mouth in 9 cases; by anus, 5 cases; not stated, 4 cases.

Referring to the classification of the parasites it may be noted that the family *Gordiidae* is divided by Camerano (1898g) into the four genera: *Chordodes*, *Parachordodes*, *Paragordius*, and *Gordius*, but Montgomery (1898) unites *Parachordodes* with *Gordius*. These genera may be distinguished by the following key, based upon the diagnoses given by Camerano.

KEY TO THE GENERA OF GORDIIDÆ.

(For forms known to occur in man in the United States, follow Roman type.)

1. End of tail not lobed 2
- End of tail bilobed 4
- End of tail trilobed *Paragordius varius* (female)
2. Cloacal aperture rentro-median, with rentro-median groove extending from it to tip of tail *Chordodes* (male)
- Cloacal aperture terminal, median; (female) 3
3. External cuticular layer, in completely developed individuals, is devoid of areolar formations *Gordius* (female)
- External cuticular layer with various kinds of areolar formations, and with hyaline clubshaped processes *Chordodes* (female)
4. A postcloacal fold present in form of a lamina *Gordius* (male)
- No postcloacal fold present 5
5. External cuticular layer presents areolar formations of a single kind, projecting very little and irregularly disposed; no interareolar refringent granules or tubercles *Paragordius* (male)
- External cuticular layer less complicated than in *Chordodes*; with only one or two kinds of areolar formations; some of these are shallow and clear, and others a little more elevated and darker are around the opening of minute canals which traverse the cuticular layers; granules or refringent tubercles frequent among the areolæ *Parachordodes* (male)

Genus GORDIUS Linnæus, 1758.

1758: *Gordius* Linnæus, 1758a, 644, 647 (*aquaticus* and *argillaceus*, Europe; *medinensis*).—Stiles & Hassall, 1905, 109 (*aquaticus* designed type).

Species GORDIUS AQUATICUS Linnæus, 1758.

1758: *Gordius aquaticus* Linnæus, 1758a, 647 (in argilla et aquis; Europe).

The following four cases of parasitism in man have been referred to this species:

CASE OF ALDROVANDUS, 1638a.—Aldrovandus does not appear to have seen any case himself, but he refers to a *Seta* or *Vitulus aquaticus*, which is usually interpreted as *Gordius aquaticus*, as follows:

"Such is the strength of this poison, if we credit the author of *De rerum natura*, that if taken in drink by man he is made faint and weak until he dies in excruciating pain. Albertus affirms the same thing, but that it is otherwise innocuous to the touch. Helvetius, the author of *Historia aquatilium*, also has seen persons dead of having drunk the *Vitulus aquaticus*. A certain man, he says, had pain around the præcordia soon after having drunk this worm; then a certain woman gave to him to drink a decoction of *Gentiana centaurium* in wine. He vomited and at once ejected the worm. If the *Vitulus aquaticus* is born in the belly of any one, the belly and stomach should be rubbed with a well-made mixture of equal parts of butter, wax, and oil. Calves, especially when full grown, swallow these worms sometimes, especially in the autumn, with vegetation, more rarely with water. There are those who believe that they [the worms] have their origin in *Bruchus*,^a which does not seem likely to me; others [believe that they take their origin] from vegetation hanging down in water troughs where cattle drink.

"When swallowed they attach themselves around the throat and arteries [=wind-pipe?]: whence the cattle gradually waste away."

CASE OF SIEBOLD, 1854.—N. N., 22 years old, daughter of peasants in good circumstances in Schliersee, in Bavarian Mountains, of robust constitution, enjoyed continued good health. Menstruation began in 15th year, without difficulty, and never became deranged. In January, 1853, patient became ill, with the following symptoms:

The girl, who was always well and red-cheeked, became pale; her disposition, otherwise gay, became changeable, then petulant, soon deeply melancholic, accompanied by an inexpressible fear of imaginary dangers, with considerable unrest and a trembling of the entire body; intense occipital headache, occasional asthmatic trouble, frequent fits of convulsive laughter, frequent sobbing and yawning for hours at a time, light horripilation, spasmodic unequal pulse. Gastric symptoms were entirely absent; there was neither nausea nor vomiting, nor loss of appetite. Patient emphatically denied having consciously eaten anything injurious.

The attending physician in Schliersee treated her for hysteria with nervines, which cured the trouble except for colicky pains in the abdomen. Nine months later the trouble reappeared; the same symptoms recurred, but with greater intensity; the trembling of the extremities, the feeling of fear, and the dyspnea became unbearable. As loss of appetite and tendency to vomit now developed, with heavy yellowish coating to the tongue, an emetic was administered. Upon the fourth vomiting the *Gordius* appeared, to the great terror of the patient. Immediately thereafter all nervous symptoms subsided, and the girl is at present as healthy and strong as formerly. Menstruation, which had not occurred since the first attack, also immediately became regular.

^a *Bruchus* Geoffr., 1764, is a coleopteron, but Harper's Latin Dictionary gives *Bruchus* as "a kind of locust without wings."

Siebold is of the opinion that the worm was not swallowed until just prior to the second attack, and that the irritation caused by its presence in the stomach caused a recurrence of the earlier hysterical symptoms. Blanchard (1890a, 89), on the other hand, thinks that the worm may have been swallowed as a larva and that it developed to the adult stage in the patient.

CASE OF PATRUBAN, 1875.—Patruban exhibited before the medical society in Vienna a specimen which he determined as *Gordius aquaticus*, sent to him by a colleague in Dalmatia, Austria, and said to have been passed in the stool of a Dalmatian boy 8 years old.

The assumption seemed justified that the worm was actually passed from the boy, because Patruban, upon expressing doubts upon this point and asking for further information, received word that a second such worm had been passed.

Opinion is expressed either that the boy swallowed a larval *Gordius*, which developed in his intestine to the adult worm, or that he swallowed a developed worm. Patruban believes the latter view more probable. Blanchard (1890a, 89), considering this case in connection with the case of Siebold, 1854, believes rather that the worm may have been swallowed as a larva and developed in the patient.

CASE OF CERRUTI & CAMERANO, 1888a-b.—In 1875, in Trabucco, Valle Superiore Mosso (Biellese), Italy, a boy of 7 years old manifested severe gastralgic pains, which confined him to bed for 24 hours, when Dr. Cerruti was called. The following day the child vomited abundant mucus with a female *Gordius villoti* [= *G. aquaticus*] 0.19 meter long, but without any trace of food. Thereupon the patient recovered.

The authors are of the opinion that this was a case of true parasitism; that the boy had become infected with the parasite in its microscopic, armed, stage; that this had developed in the wall of the stomach, then returned to the lumen of the stomach, when it caused the symptoms observed.

?CASE OF CAMERANO, 1888f, 397.—Camerano states that Professor Pavesi sent to him a female *Gordius villoti* [= *G. aquaticus*] found at Brescia, Italy, in December, 1874, on a dissecting table near a human cadaver. There is, however, no evidence that the worm came from the cadaver.

Doubtful species *GORDIUS CHILENSIS* E. Blanchard, 1849.

1849: *Gordius chilensis* E. Blanchard, 1849d, 109 (Valparaiso, Concepcion, etc., Chili).

ORIGINAL SPECIFIC DIAGNOSIS.—*Gordius*: "G. Gracilis, cinereofuscus, obscurus; capite nigro."

TYPE LOCALITY.—Valparaiso, Concepcion, etc., Chili.

Authors admit that this species is too incompletely described to be accepted at present. In the original account of the worm it is stated that the Indians fear it, believing that if introduced into the body it causes serious disease. No specific case seems, however, to be reported.

Genus PARAGORDIUS Camerano, 1897.

1897: *Paragordius* Camerano, 1897g, 368, 399-400 (*tricuspidatus*, *emeryi*, *stylosus*, *varius*).—Montgomery, 1898, 43 (type *varius*).

Two species of this genus have been reported as parasitic in man, namely, *P. varius* in North America and *P. tricuspidatus*, in Europe. As *P. varius* is the one of greater interest to American physicians, its description is given here in detail, based upon Montgomery's work.

Species PARAGORDIUS VARIUS (Leidy, 1851) Camerano, 1897.

(Figs. 35-55.)

1851: *Gordius varius* Leidy, 1851, 262 (U. S. A.)

1897: *Paragordius varius* (Leidy, 1851) Camerano, 1897g, 399, 402.

SPECIFIC DIAGNOSIS.—*Paragordius*: Dimensions. Length of largest male seen, 350 mm.; greatest diameter, 0.9 mm. Length of largest female, 290 mm.; greatest diameter (of a flattened individual), 2 mm. The males are more slender and average considerably shorter than the females.

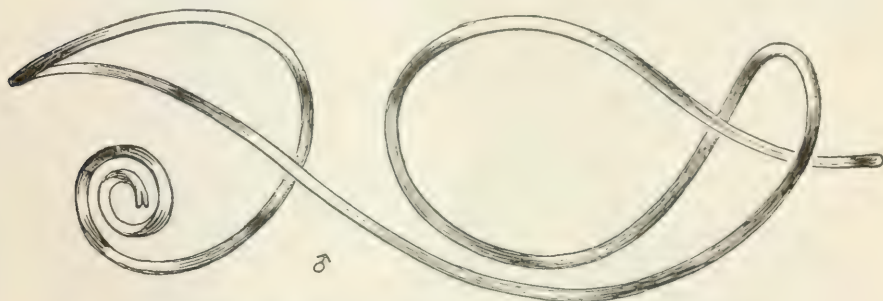


FIG. 35.—Male specimen of *Paragordius varius*, from man. $\times 4$. Original.

Color: Color usually lighter in the females than in the males, varying from a light brown or yellowish to a dark brown (the larger individuals usually darker). The tip of the head is white or a pale brownish. Just behind there is a dark ring of color, usually rusty brown or even black, rarely pale. This ring is darkest at its anterior edge, and darker on the dorsal than on the ventral side of the body. At least a trace of this ring is to be seen on all mature specimens, though the intensity of its coloration is very variable.

Especial diagnostic characters: The trilobation of the posterior end of the female, the long and cylindrical tail lobes of the male, the oblique truncation of the head end, and the usually very dark-colored ring around the head, render this species very easy of identification.

Cuticle: On cross section an outer thin hyaline layer is seen, and an inner, much thicker fibrous layer. Embedded in the hyaline layer are small lozenge-shaped bodies, which stain more deeply than any other portion of the cuticle, and which correspond to the areolæ seen on surface views. The external surface of the hyaline layer of the cuticle is marked by short conoidal processes of the same structure as the hyaline matrix. These are not seen on surface views. On surface views the cuticle appears areolated. The areolæ are small, variable in size and form, and irregularly arranged. Sometimes they occur in groups, sometimes in interrupted longitudinal rows. Their arrangement varies both in different individuals, as well as on different portions of the same individual. The areolæ are

irregularly polygonal in outline. In one female larger brown-colored areoles were present in addition to the smaller, lightly colored ones. The former were mainly arranged in the form of longitudinal ridges and were irregularly star-shaped in outline.

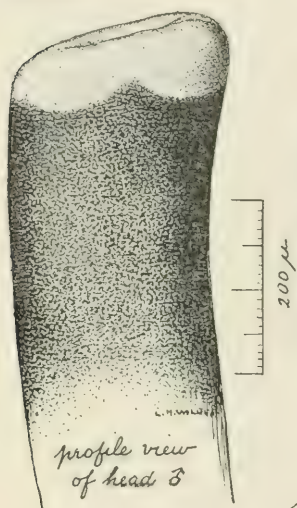


Fig. 36.

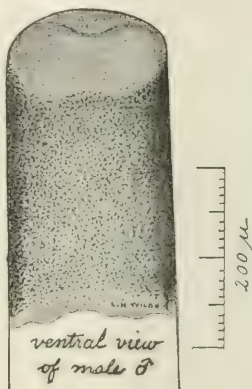


Fig. 37.



Fig. 38.

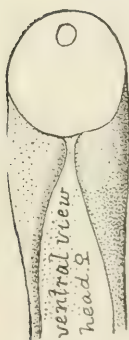


Fig. 39.

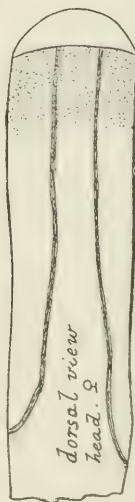


Fig. 40.

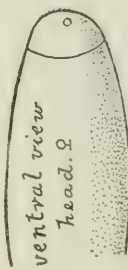


Fig. 41.

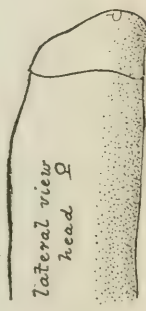
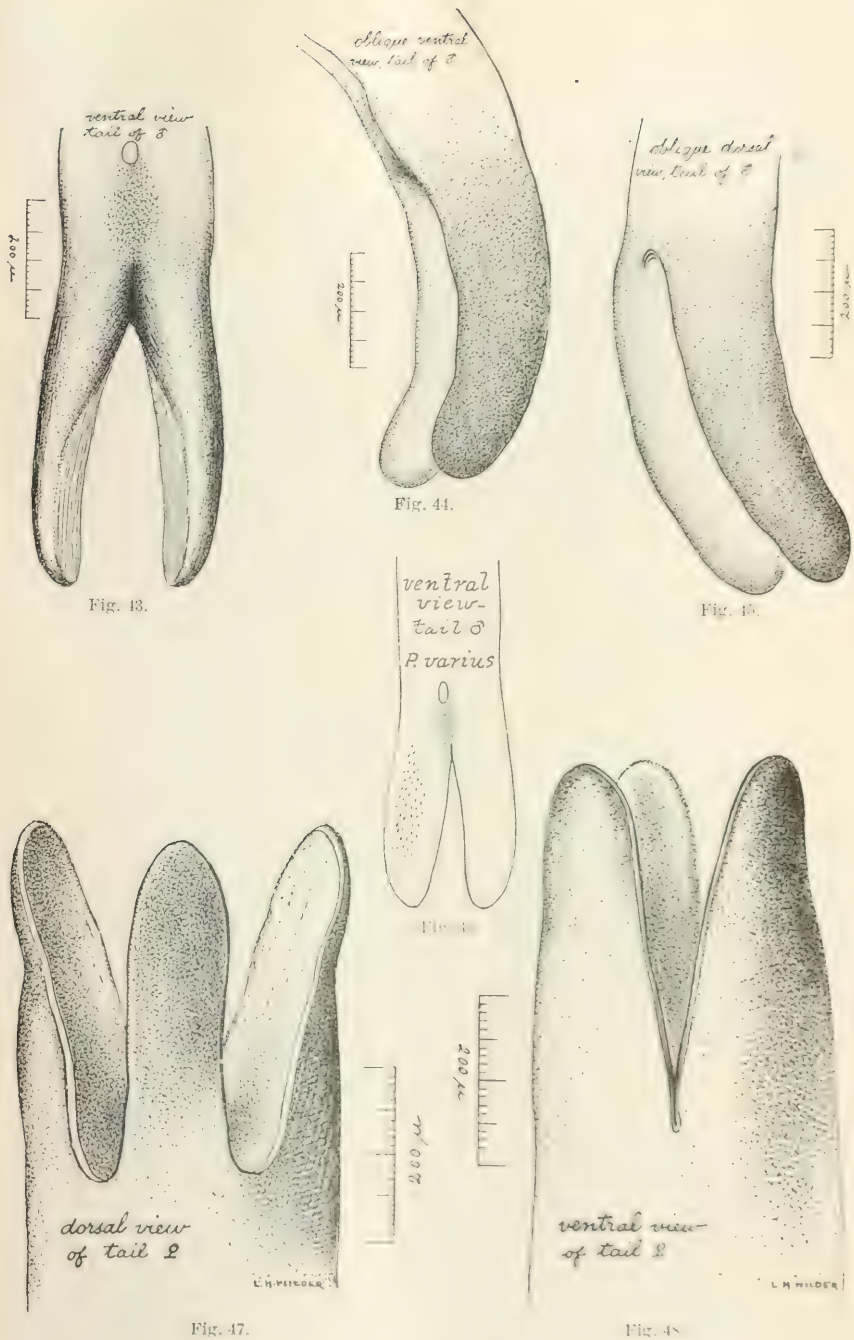


Fig. 42.

FIGS. 36-38.—Three views of head of same. Enlarged. Original.

FIGS. 39-42.—Four views of head of female *P. varius*. Enlarged. (After Montgomery, 1893, figs. 83a, 83b, 84-85.) (The head of my female specimen is not suitable to illustration, and on this account Montgomery's figures are taken, although they are not entirely in harmony with my specimen.)

Form of male: The anterior end as in the female, but the body more slender. The tail lobes are comparatively long and slender, cylindrical in shape, and obtusely rounded terminally. Small conical spicules occur on the medio-ventral surfaces of the anterior half of the lobes, and short hairs on their anterior surfaces. The elongate cloacal aperture lies in the medio-ventral line of the body, anterior to the tail lobes.



FIGS. 43-45.—Three views of tail of male. Enlarged. Original.

FIG. 46.—Ventral view of tail of male. Enlarged. (After Montgomery, 1898, p. 8.)

FIGS. 47-48.—Dorsal and ventral views of tail of female. Enlarged. Original.

Form of the female: The anterior and posterior portions of the body are narrower than the middle, the decrease in diameter being very gradual; the anterior is narrower than the posterior end. The head end is obliquely truncated in such a way that the antero-ventral margin projects farther forward than does the antero-

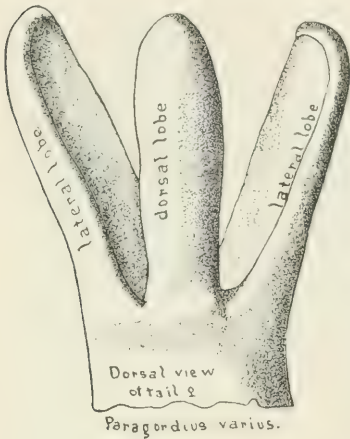


Fig. 49.

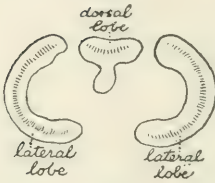


Fig. 50.

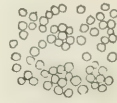


Fig. 54.

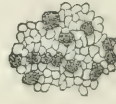


Fig. 53.



Fig. 52.

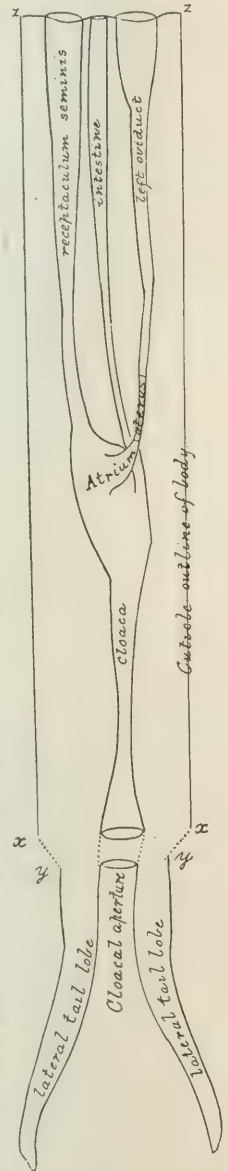


Fig. 51.

FIG. 49.—Dorsal view of tail of female. Enlarged. (After Montgomery, 1898, fig. 88.)

FIG. 50.—Cross section of same. Enlarged. (After Montgomery, 1898, fig. 80.)

FIG. 51.—Optical section of the caudal end of a female *P. varius*, showing anatomy; *x-y*, omitted portion, about 10 times the length of *x-z*. Enlarged. (Reduced from Montgomery, 1898, fig. 86.)

FIGS. 52-53.—Transverse section and surface view of cuticle of female. Enlarged. (After Montgomery, 1898, figs. 91 a-b.)

FIG. 54.—Surface view of cuticle of male. Enlarged. (After Montgomery, 1898, fig. 93.)

dorsal; this truncated plane, which forms the terminal aspect of the head, is very nearly flat. The mouth lies near the ventral edge of the truncated plane. The posterior end is trilobed, there being one dorso-median and two latero-ventral lobes; these lobes have no cuticular spines on their surface, and in the great majority of the numerous specimens examined are of equal length. Two specimens in the Harvard collection were exceptions to this equality in length; in one the dorsal lobe was slightly longer than the others, in the other slightly shorter. But the dorsal lobe is narrower than the others, and further differs from the latter in having an elevated median ridge on its ventral surface, so that on cross section it appears triradiate. The lateral lobes are crescent-shaped on cross section. The cloacal aperture, wholly hidden by these lobes, lies at their

base and between them, so that the cuticle and epidermis of the inner surface of the lobes are directly continuous with the cuticle and epithelium of the cloaca. The lobes may be either parallel or divergent, and hence are probably movable.

Comparisons: This species has the greatest affinity to *Paragordius tricuspidatus* (Dufour); but it differs from it in that there are spicules or spines upon the tail lobes of the female, and in that the dorsal is narrower than the lateral lobes; further, in *P. varius* the areoles of the cuticle are frequently arranged into rows or groups.

GEOGRAPHIC DISTRIBUTION.—North America (California, Canada, Illinois, Kansas, Maine, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Virginia); Guatemala; and it has also been observed in Mexico, Peru and Bolivia. It appears to have a very extensive range, and it and *G. aquaticus robustus* are the most abundant forms in the northeastern portion of the United States.

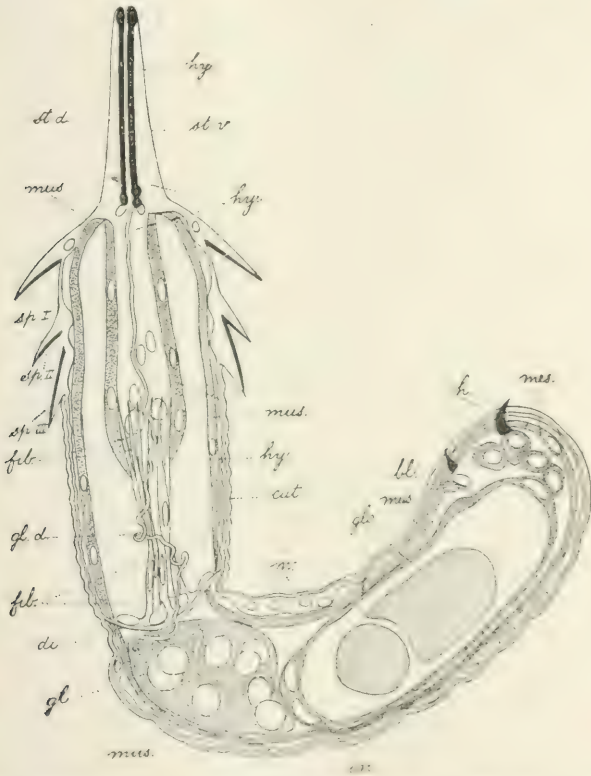


FIG. 55.—Larva of *Paragordius varius*, with extruded proboscis; *bl.*, blastopore; *cut.*, cuticle; *di.*, diaphragm; *fib.*, fiber cells; *gl.*, gland; *gl. d.*, gland duct; *glo.*, globules within intestine; *h.*, cuticular hooks; *hy.*, hypodermis; *in.*, intestine; *mes.*, mesenchyme; *mus.*, musculature; *nr.*, nervous thickening of hypodermis; *sp. 1* to *sp. 3*, spicules of rows 1 to 3; *st. d.*, dorsal stilettes; *st. v.*, ventral stilettes. (Reduced from Montgomery, 1904, fig. 36.)

The following four cases of infection with this worm have been found in North America:

CASE OF KIRTLAND, ante 1861.—I have been unable to find the original account of this case. Diesing (1861a, 604) refers to it simply by the words "Ohio ex ano puellae expulsus (Kirtland)," and all later authors seem to report it on basis of this passage.

UNPUBLISHED CASE OF BOWDITCH.—In my host catalogue of parasites I have the following entry: "*Gordius trifurcatus-varius*, determined by — ? —, collected by Doctor Bowditch, host *Homo*, location — ? —, locality Saco, Maine, U. S. A., Cat. no. 111 Boston Soc. Nat. Hist." I have been unable to obtain any further details regarding this case.

NEW CASE. In February, 1902, Dr. W. G. MacCallum, of Johns Hopkins Hospital, forwarded to me for determination two worms which he had received from Dr. W. J. Stevenson, London, Ontario. The label stated that these specimens were passed in large quantities from the intestine of a girl 13 years old. Examination showed them to be *Paragordius varius*.

In a personal letter to me Doctor Stevenson states that the child exhibited no special symptoms. The worms were passed while the girl was sitting on a chamber, and the mother noticed them immediately. They seemed as stiff as wire, a fact which might give rise to the suspicion that they were dried and were in the chamber before the girl used it. One week later similar worms were again passed. The mother thought that the child had worms, because of her picking her nose and crying out during sleep. The child was accustomed to eating a great many apples. No further details are accessible to me.

NEW CASE.—U. S. P. H. & M. H. S. specimen no. 9565 represents one male and one female specimen of *Paragordius varius*, forwarded to me by Dr. Joseph L. Miller, of Chicago, Ill., for determination. Doctor Miller wrote:

I send you under separate cover a specimen which was given to me recently by a physician who reported that a patient had vomited it.

No further data regarding this case could be obtained.

Species PARAGORDIUS TRICUSPIDATUS (Dufour, 1828) Camerano, 1897.

1828: *Filaria tricuspidata* Dufour, 1828d, 222–224, pl. 12c (in *Gryllus burdigalensis*; France).

1856: *Gordius tricuspidatus* (Dufour, 1828) Meissner, 1856, 55.

1897: *Paragordius tricuspidatus* (Dufour, 1828) Camerano, 1897g, 399, 400.

The following case of parasitism has been ascribed to this species.

CASE OF R. BLANCHARD, 1897d.—Locality: Bassac (Charente), France. On May 1 a boy 15 years old, not in the habit of drinking wine, had just taken a full glass, when a few moments later he felt in his throat a peculiar tickling, similar to that occasioned by the presence of a hair. He inserted his fingers and encountered a sort of a thread, which he drew out. About 15 days before this occurrence the boy had taken a drink of water from a small brook; since then he had experienced a slight colic which disappeared after the expulsion of the worm. This worm was sent by Doctor Boiteau to Paris and was determined by Blanchard as *Gordius tricuspidatus*.

Species **PARAGORDIUS CINCTUS** Linstow, 1906.

1906: *Paragordius cinctus* Linstow, 1906, 245, fig. 11; Africa.

Linstow records this worm for man in Transvaal, Lydenburg, but gives no details regarding the case. The specimen from man was found in the collection of the Berlin Museum.

Genus **PARACHORDODES** Camerano, 1897.

1897: *Parachordodes* Camerano, 1897g, 368, 389-398 (*vejovskyi*, *raphaelis*, etc.).—Stiles & Hassall, 1905, 127 (*tolosanus* as type).

Four species of this genus have been recorded as parasitic in man.

Species **PARACHORDODES TOLOSANUS** (Dujardin, 1842) Camerano, 1897.

1842: *Gordius tolosanus* Dujardin, 1842, 146 (probably France).

1897: *Parachordodes tolosanus* (Dujardin, 1842) Camerano, 1897g, 389 bis, 398 (Europe).

CASE OF DEGLAND, 1823.—The original account of this case is not accessible to me, but the following statements are taken from various authors, chiefly from Blanchard, 1890a, 90:

Following the administration of an emetic, a boy of 8 years of age vomited a worm, 14 to 16 cm. in length, which Degland referred to "*Gordius aquaticus*." Villot, 1884, 88, however, believes that it was a *Parachordodes tolosanus*. From Blanchard's abstract of this case, it is not quite clear to me whether he considers the case identical with that reported by Cloquet (see below) or whether he simply considers the parasites as specifically identical. Not being able to obtain Degland's paper, I am unable to settle this point definitely, but from the fact that Blanchard gives the age of Degland's patient as 8 years, while Cloquet's patient does not appear to have been so young, I give the two cases here as distinct.

CASE OF CLOQUET, 1822a-b.—M. Raymond Pontier, a physician in Uzerches, sent the parasite in question to Varélaud, Paris, who gave it to Cloquet for determination. The latter described it as a new species, *Ophiostoma pouterii* 1822a, 99, and *Ophiostoma pouterii* 1822b, 32. This is classified by Blanchard and by Railliet as a synonym of *Gordius tolosanus*.

The worm was vomited by a farmer near Uzerches; he had been subject to attacks of epilepsy for some years, but these ceased permanently as soon as the worm was expelled.

The worm was cylindrical, 9 inches' long by half a line in its greatest diameter; brown in color, finely annulated with clearer circles; its "mouth" [=tail] was "bilabiate," the under "lip" being longer than the upper.

CASE OF FIORI, 1881a.—In April, 1881, Fiori, the attending physician at the Torino jail, administered 12 grams of thymic acid to a male prisoner 42 years old who was affected with uncinariasis. In the washings of the first stool passed a long, brown, filiform, actively motile worm was found in addition to the hook worms. This long worm was determined by Dr. Daniele Rosa as a male *Gordius tolosanus* Duj. seu *G. subbifurcus* Siebold. The symptoms noticed were in harmony with uncinariasis and could not be definitely attributed to the *Gordius*.

?CASE OF CAMERANO, 1888f, 397.—Camerano relates that Professor Pavesi sent to him a female *Gordius tolosanus* found at Brescia, Italy, December, 1874, on a dissecting table near a human cadaver. There is, however, no evidence that the worm came from the cadaver.

Species **PARACHORDODES PUSTULOSUS** (Baird, 1853) Camerano, 1897.

1853: *Gordius pustulosus* Baird, 1853a, 37; 1853b, 20, pl. 30, fig. 4 (in *Blaps obtusa*; London, England).

1897: *Parachordodes pustulosus* (Baird, 1853) Camerano, 1897g, 389 bis, 396-397 (Europe; China).

One case of infection has been referred to this species.

CASE OF PARONA, 1901.—In 1901 a woman 45 years of age, in Lodi, Italy, passed a worm per anum; the symptoms had not been severe; there was a frequent and annoying sensation of a moving body in the abdomen, with rectal and anal pruritus, and an obstinate catarrhal discharge from the anus. These symptoms lasted about three months, but suddenly ceased after the discharge of the worm.

Species of **PARACHORDODES VIOLACEUS** (Baird, 1853) Camerano, 1897.

1853: *Gordius violaceus* Baird, 1853a, 36; 1853b, 20, pl. 30, fig. 3 (in *Curabus violaceus*; Bermickshire).

1897: *Parachordodes violaceus* (Baird, 1853) Camerano, 1897g, 289 bis, 392-393 (Europe; Transcaucasia).

One case of infection has been referred to this species.

CASE OF TOPSENT, 1900, 86-91.—Topsent presented before the Société scientifique et médicale de l'Ouest, Rennes, France, a living male specimen of *Gordius violaceus*, which had been vomited, February 22, 1900, by a farmer, 34 years old, near Fougères. Patient had experienced gastric trouble for about a month; for 8 days prior to expelling the worm he had experienced an uneasiness in his throat, sensation of a lump which changed position, and a tickling which produced a continual desire to vomit. Upon expelling the worm there was entire relief.

Species **PARACHORDODES ALPESTRIS** (Villot, 1884) Camerano, 1897.

1884: *Gordius alpestris* Villot (1884), 44-45.

1897: *Parachordodes alpestris* (Villot, 1884) Camerano, 1897g, 389 bis, 393-394.

One case of infection with this species has recently been reported.

CASE OF GUÉGUEN, 1905, 398-400.—A laborer, 34 years old, at Chabanaïs (Charante), France, was accustomed to drinking at an exhausting pump used for draining the yards. Early in July, after having drunken of this stagnant water, coming both from springs and rains, he was seized with colic which lasted two days and then ceased for about two months. Then loss of appetite developed, together with vomiting after meals; this condition of malaise lasted five days and during the last two days was accompanied by colic. On the fifth day, after a light meal, together with a drink of pure water, vomiting occurred, resulting in the expulsion of a large female *Chordodes*, 34.4 cm. long, ?*Gordius alpestris* Villot [= *Parachordodes alpestris*]. Guéguen believes the worm must have been swallowed when young, and that it developed to its present size in the man's intestine.

Genus and species undetermined.

CASES OF WARD, 1903.—In referring to Kirtland's case, Ward states that "two other unpublished cases have recently been communicated to me from Michigan and Maryland."

In reply to a personal letter Ward has informed me that—

"I remember the cases reasonably distinctly and I am sure of the fact that I was unable to secure the specimens, so that the species must remain undetermined. I am also under the impression that the practitioners could give no information in regard to the cases."

MEDICAL SIGNIFICANCE OF HORSEHAIR WORMS.—Reference has already been made to the popular view in certain localities to the effect that these worms, if swallowed, produce very serious and even fatal results. The cases summarized above do not, however, bear out this view, but they support the opinion usually held by physicians and zoologists that horsehair worms are not dangerous. In fact, with the exception of Cloquet's and Siebold's cases, the symptoms seem to have been rather slight, or, at least, not severe.

In this connection it is interesting to note that Bacounin (1790a, 34) fed large horsehair worms to dogs, cats, and birds without serious effects; then he swallowed two such worms himself. He states that he felt a kind of malaise, which soon disappeared. After this he fed six such worms to a boy without any unfavorable results.

KEY TO NORTH AMERICAN SPECIES OF GORDIIDÆ.—Probably almost any species of this family may occur in man. The following key, slightly rearranged, from a paper by Montgomery (1899), will enable the reader to determine the North American species:

1. Caudal extremity trilobed.....*Paragordius varius* (female), p. 59
- Caudal extremity bilobed, spirally enrolled (*Paragordius* and *Gordius* males)....3
- Caudal extremity not lobed (*Chordodes* male and female, *Gordius* female).....2
2. Caudal extremity spirally inrolled, narrower than the preceding portion of body and with a depression or groove on its ventral surface (*Chordodes* male)....10
- Caudal extremity not spirally inrolled, not narrower than the preceding portion of body (*Chordodes* and *Gordius* females).....12
3. A sharp V-shaped ridge behind cloacal aperture.....4
- No sharp V-shaped ridge behind cloacal aperture.....5

PARAGORDIUS and GORDIUS males.

4. Cuticle marked with large white spots; male.....*Gordius aquaticus* (Linnaeus)
- Cuticle not marked with white spots.....5
5. A parabolic line of hairs on caudal lobes; male.
Gordius aquaticus difficilis Montgomery
- No line of hairs on caudal lobes; male.....*Gordius aquaticus robustus* Leidy
6. A longitudinal line of hairs on each side of cloacal aperture; male.
Gordius lineatus Leidy
- No line of hairs on each side of cloacal aperture.....7
7. Head end obliquely truncated; male.....*Paragordius varius* (Leidy), p. 59
- Head not obliquely truncated.....8

8. No conical spicules behind cloacal aperture; caudal lobes cylindrical; male.
Gordius platycephalus Montgomery
 Conical spicules behind cloacal aperture.....9
9. Caudal lobes short, thick, nearly conical; male.
Gordius densareolatus Montgomery
 Caudal lobes nearly cylindrical; male.....*Gordius longareolatus* Montgomery

CHORDODES male.

10. Cuticular areoles longer than high; on or between them are small circular pits; male.....*Chordodes occidentalis* Montgomery
 Cuticular areolæ higher than long..... 11
11. Spines on summits of the highest areoles (papillæ); male.
Chordodes puerilis Montgomery
 No spines on summits of the highest papillæ; male.
Chordodes morgani Montgomery

CHORDODES and GORDIUS females.

12. Caudal end not noticeably enlarged *Gordius* (females), 13
 Caudal end swollen, somewhat knob-shaped, slightly constricted off.
Chordodes (females), 19

GORDIUS females.

13. Elevated cuticular areoles on entire surface of body..... 14
 Without elevated cuticular areole on entire surface..... 17
14. With paired dark stripes in median lines; females... *Gordius leidyi* Montgomery
 No dark stripes in median lines..... 15
15. Areoles elongated in long axis, and well separated from one another; female.
Gordius longareolatus Montgomery
 Areoles not elongated in long axis of body..... 16
16. Areoles closely apposed, tending to produce longitudinal ridges; female.
Gordius lineatus Leidy
 Areoles more or less confluent, tending to produce transverse rows; head usually cylindrical; female *Gordius densareolatus* Montgomery
 Areoles usually separated, interareolar groups of fine hairs, head usually flattened; female *Gordius platycephalus* Montgomery
17. Cuticular areoles only at ends of body; female.
Gordius aquaticus difficilis Montgomery
 Cuticular areoles entirely absent 18
18. Cuticle marked with white spots; female *Gordius aquaticus* Linnæus
 Cuticle without white spots; female *Gordius aquaticus robustus* Leidy

CHORDODES females.

19. Cuticular areoles longer than high; on or between them circular pits; female.
Chordodes occidentalis Montgomery
 Cuticular areoles higher than long; female.....20
20. Spines on summits of highest areoles; female.... *Chordodes puerilis* Montgomery
 No spines on summits of highest areoles; female.
Chordodes morgani Monticelli

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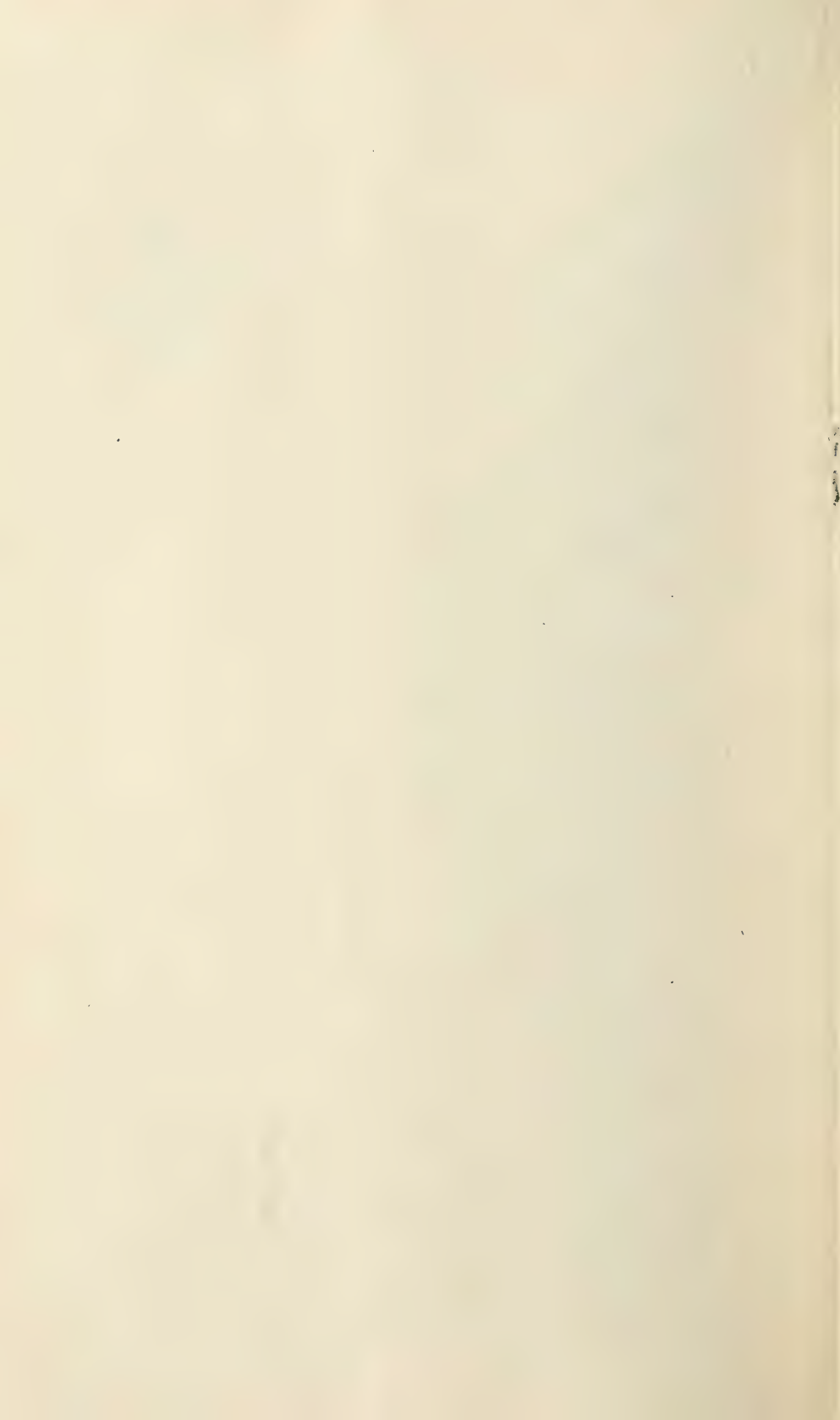
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